AGRICULTURAL ENGINEERING

APRIL • 1955

In this Issue . . .

Agricultural Engineers Develop New Concept for Self-Propulsion of Farm Machines

•

Rigid-Pillar Construction Facilitates Erection of Farm Buildings

•

Drainage Pumping Reclaims Land Areas Low in Elevation for Agricultural Production

•

Method of Rapidly Determining Air-Flow Values in Grain-Drying Structures

•

Engineering Research Progress Keeps Pace with Fast-Changing Technology of Agriculture

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AGRICULTURAL ENGINEERING

Established 1920

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Faced with the challenge of boosting farm profits, ag engineers are looking for new production tools to reduce operating costs. And among the most important tools on any farm are its buildings.

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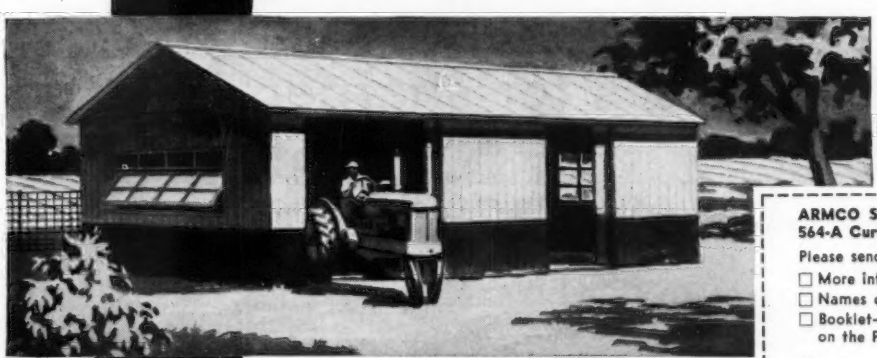
Because they're fire-resistant, steel buildings can be put close together in a compact layout. And as a farm's needs change, these buildings can be moved or added to without loss of materials.

Steel buildings painted white outside reflect the summer sun, help keep interiors cool. No other uninsulated building material gives better results. This means more comfortable quarters for livestock and better working conditions for the farmer.

To keep building maintenance at minimum, many manufacturers of steel farm buildings use Armco ZINCGRIP—a specially zinc-coated steel that gives long protection against rust. In 18 years of service, ZINCGRIP has proved itself as the dependable, low-upkeep steel for farm use.

If you are designing steel buildings or equipment, you can obtain further information on this special sheet steel by sending the coupon below.



A steel building like this machinery shed can be put up by an inexperienced crew in a few days after the foundation has been laid. This includes installation of all doors and windows—which can be added wherever and whenever needed.

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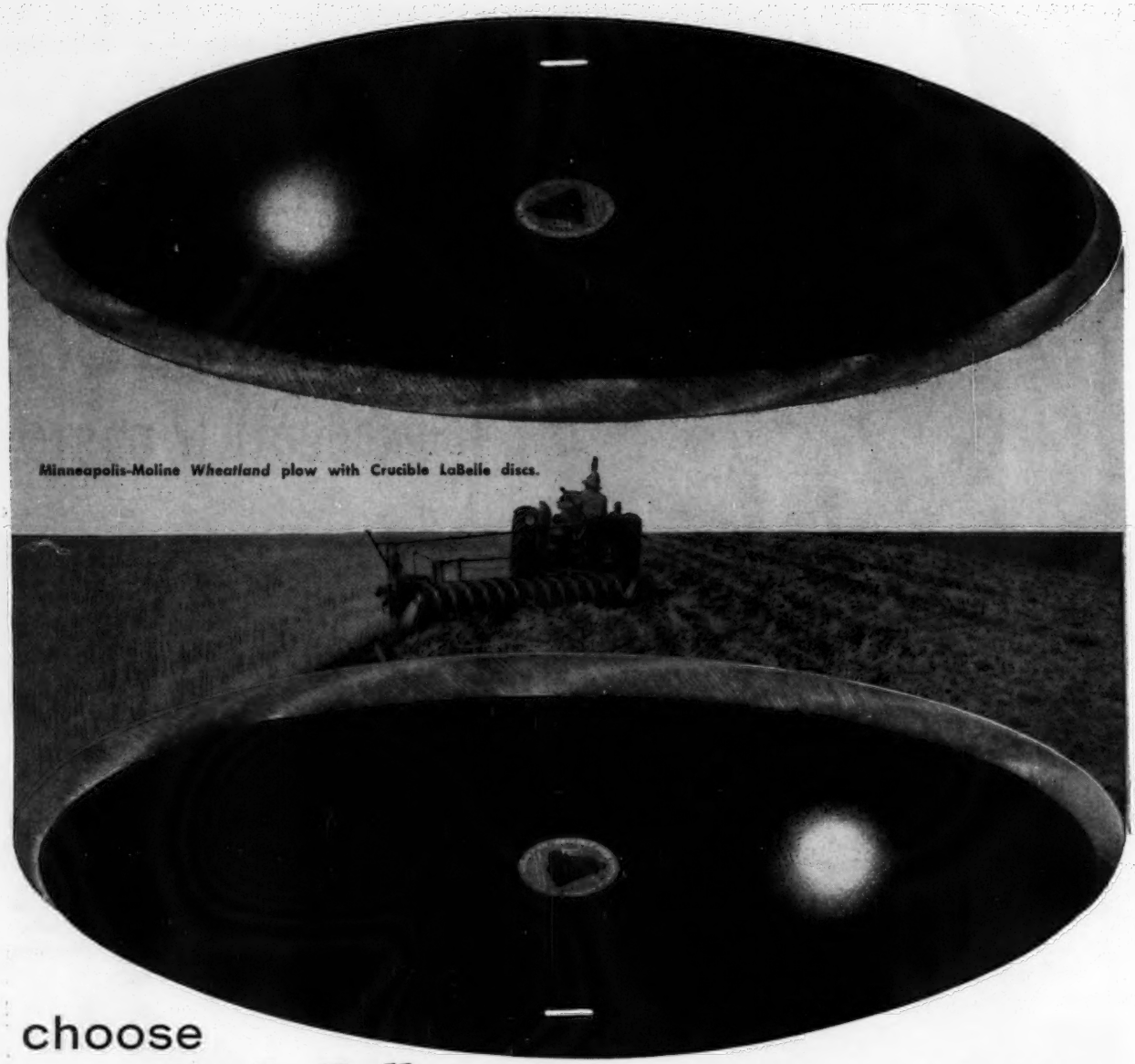

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There's a LaBelle disc for every type of harrow and plow equipment. Next time you need discs, specify LaBelle. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

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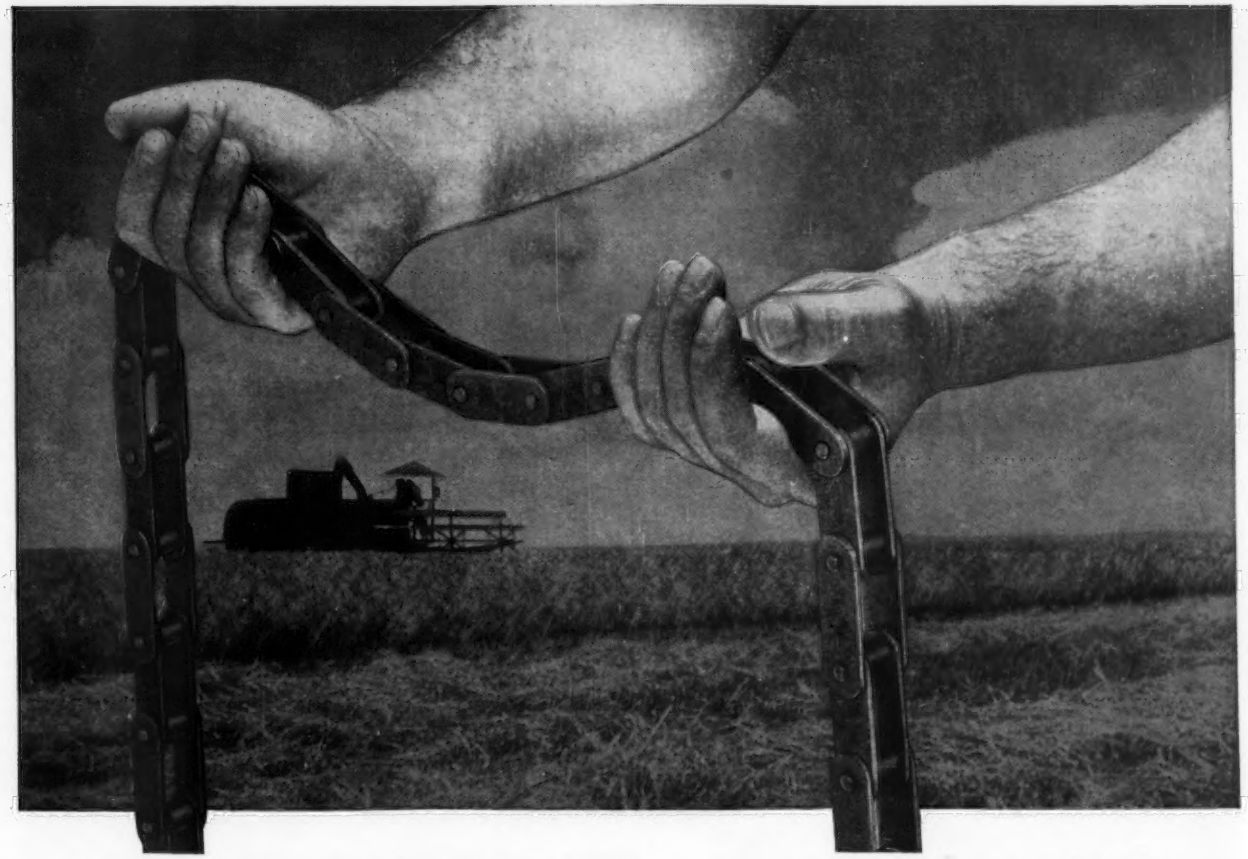
Attention: Agricultural machinery designers . . .



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No one chain serves every purpose . . .
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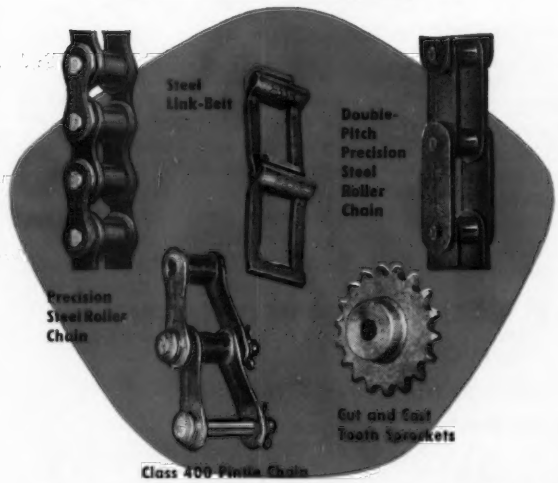
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Like all Link-Belt chain, it's built to *outlast, out-perform others in its class.* Manufacturing refinements, such as closer heat treat control and controlled press fits, assure maximum wear life. What's more, "AG" roller chain has Link-Belt's famous *lock-type bushings.* This special process locks the inside sidebars on the bushings more securely than conventional methods, eliminates a common cause of stiff chain.

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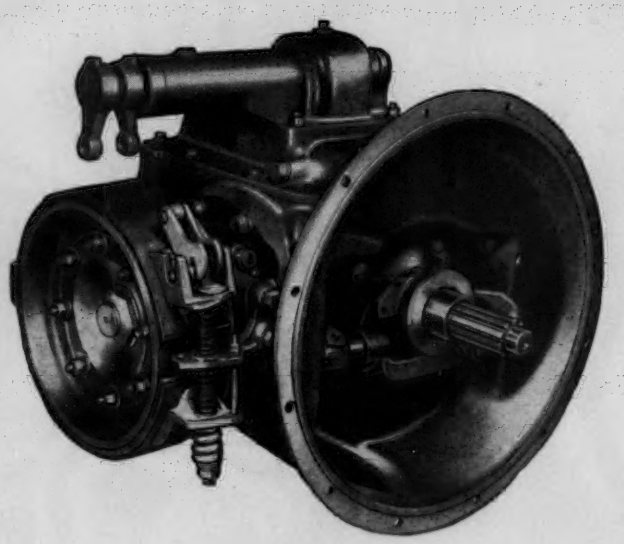

your engineers
PLUS
Clark engineers

Your engineers may have a dynamic idea for increasing operating efficiency of a certain piece of equipment. Their major problem is to be *certain* that the axle-transmission drive units will withstand this newly-visioned power and operational efficiency.

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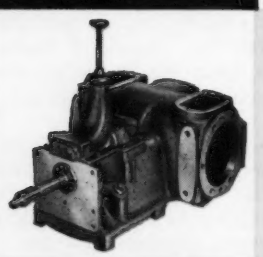

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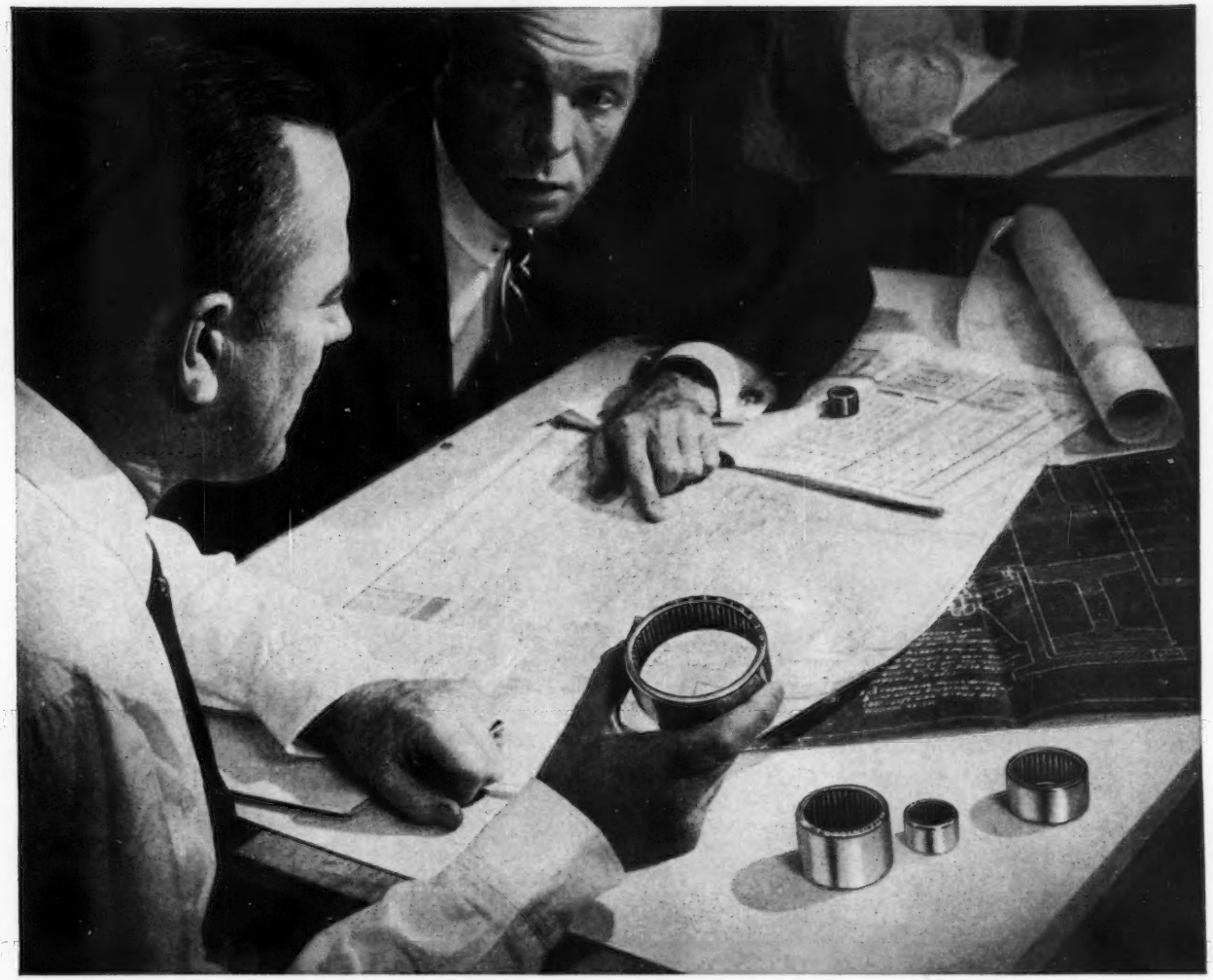

His wide experience with **TORRINGTON NEEDLE BEARINGS** may solve *your* problem

Here is a Torrington Staff Engineer working on a new application for Torrington Needle Bearings.

He's made a thorough study of the field report from the District Engineer. He's consulted the files for similar applications—files which comprise the complete history of Needle Bearing applications to date. He's talked with—and may even have worked with—the customer's own design staff. Now he's back at his board with the Chief Bearing Engineer after he has carefully analyzed speeds, loads and deflections.

This product could be yours. The unmatched experience in Needle Bearing applications of our Engineering Department can be brought to bear on your anti-friction bearing problems. And you can gain for your product the unique advantages that the Needle Bearing has given to thousands of products throughout industry in the past twenty years. Let us help you make the Needle Bearing "standard equipment" in your product.

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- long service life
- compactness and light weight
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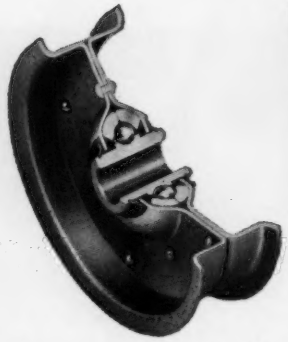
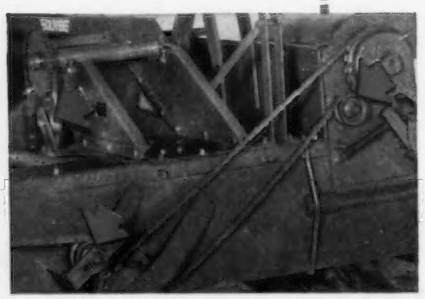


"package unit"
IDLER PULLEY ASSEMBLIES

Speed Assembly...
reduce cost on
OLIVER Model 50 BALER



New Oliver Model 50 Twine-Tie Baler. Closeup of main transmission housing and drive (guard removed) shows how BCA *package unit* Idler Pulley Assemblies are incorporated in design. Sealed ball bearings reduce friction and prolong life... do not require greasing or oiling.

Low first cost... low upkeep cost. Smooth, efficient, trouble-free power. This sums up the new Oliver Model 50 Baler. That's why, in designing this two-way twine-tie model, Oliver Corporation engineers incorporated BCA ball bearing Idler Pulley Assemblies at crucial points in the chain drive. These sealed, pre-lubricated *package units* give ball bearing dependability at low cost. They're effectively sealed against grit and dust... virtually eliminating field servicing chores.

The Oliver Corporation, as well as other big farm implement manufacturers, finds that BCA *package units* also speed up assembly time. BCA Idler Pulley Assemblies are adaptable to many other agricultural applications, including combines, forage harvesters, grain elevators, corn and cotton pickers, spreaders. Sheave design can be varied for use with flat belts, V-belts, or chains. If you have a bearing problem, BCA engineering cooperation and design assistance will provide the right solution.

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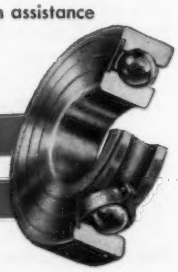


Pioneers of pre-lubricated *package unit* ball bearings for agriculture

HYDRAULICS FOR MOBILE EQUIPMENT

VOL. 2

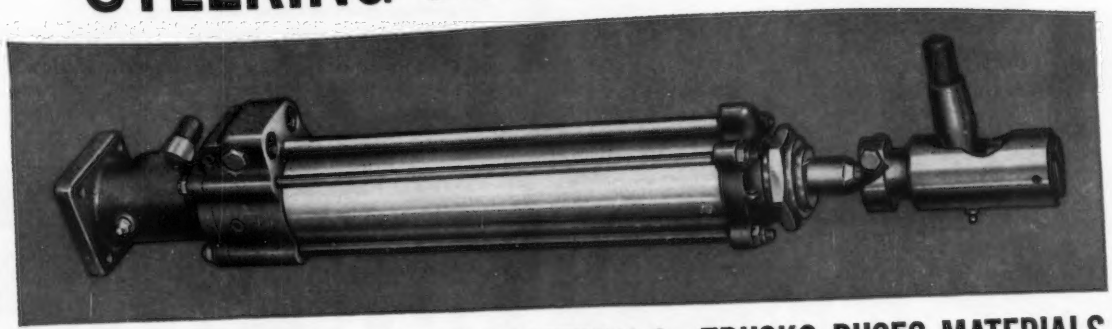
Mobile Equipment News

VICKERS INCORPORATED, DETROIT, MICHIGAN

IMPROVES PERFORMANCE • CUTS COSTS

NO. 5

New! VICKERS® HYDRAULIC POWER STEERING BOOSTER...SERIES S23



LATEST DEVELOPMENT in POWER STEERING for TRUCKS, BUSES, MATERIALS HANDLING VEHICLES, ROAD CONSTRUCTION and MINING MACHINERY

More compact . . . improved in operating characteristics . . . this new Vickers Steering Booster, Series S23 is an important new development in power steering for many vehicles. Application is much easier because it requires less space . . . and ultimate costs are substantially lower. Series S23 thus opens the way to fingertip ease of steering for a wide range of additional vehicles.

Like the preceding models, Series S23 has hydraulic lock against road shock. Bumps, chuckholes, blown front tires, obstructions, etc., cannot spin the steering wheel or jerk it out of control. This is a safety factor of great importance.

Series S23 Boosters are provided either with (Model S23R) or without (Model S23N) an integral relief valve. Model S23N is used with Vickers VT16 and VT17 pumps that have integral volume control and relief valve. When the larger volume Series V200 pump is used and a volume control is required in the circuit, the S23N is used with a separate combination valve (see Series FM2 below). Model S23R is used with the Series V200 pumps that have no integral valving, for applications where a volume control is not required.

ASK FOR NEW BULLETIN M5106

MORE VERSATILE INSTALLATION

In Series S23 Boosters, the servo ball stud housing is symmetrical, and can be assembled in any one of four positions. This and the compactness of the Booster makes application easier . . . increases the number of applications which can be made without major engineering changes. Series S23 Boosters can be mounted interchangeably with Models S6-277 and S6-279 Boosters.

REQUIRES LESS SPACE

The new booster has been reduced in size by the redesign of the servo control valve. The tube connecting the servo valve to the rod end has been relocated and is now on the same side as the fitting connection. As a result of these changes, Series S23 requires less space . . . works in closer quarters.

7062

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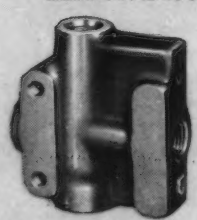

Five sizes of Series FM2 Valves were developed primarily for hydraulic power steering on trucks, buses and materials handling equipment where the pump does not include a volume control valve. The FM2 improves steering booster performance by providing a relatively constant volume of oil regardless of engine speed variations. An integral relief valve is included.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

AUTO-LITE TRANSPORT SPARK PLUGS

Farmers get top performance from their trucks, tractors and heavy-duty equipment with this new plug because:

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WIDEST HEAT RANGE—assures peak efficiency through widest range of operating conditions from heavy pull to light idling.

Original factory equipment on many leading makes of trucks and tractors. Remember, Auto-Lite is a complete spark plug line, with standard, transport and resistor types for all service conditions.

ORIGINAL

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Now available! A newly designed "Sta-ful" Battery especially built for tractors, light trucks and other off-the-road machinery. Auto-Lite "Sta-ful" needs water only ⅓ as often in normal tractor use. New rugged case withstands heavy shocks . . . Fibre-glass insulation gives longer life . . . extra liquid reserve protects battery plates to save customers time and worry. Auto-Lite is a complete battery line—specified as original equipment for many leading makes of cars, trucks, and tractors.

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Auto-Lite is a complete line—featuring sensational new Neosheath Spark Plug Wire Sets that keep plugs dry, famous Flextrand Primary Wire that is easier to install, Auto-Lite Battery Cable with the new anti-corrode Power-Line Terminal. Auto-Lite Cable Products are original factory equipment on leading makes of tractors, trucks and farm equipment.

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EQUIPMENT The Key to bigger profits for Farm Equipment Dealers

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THE ELECTRIC AUTO-LITE COMPANY

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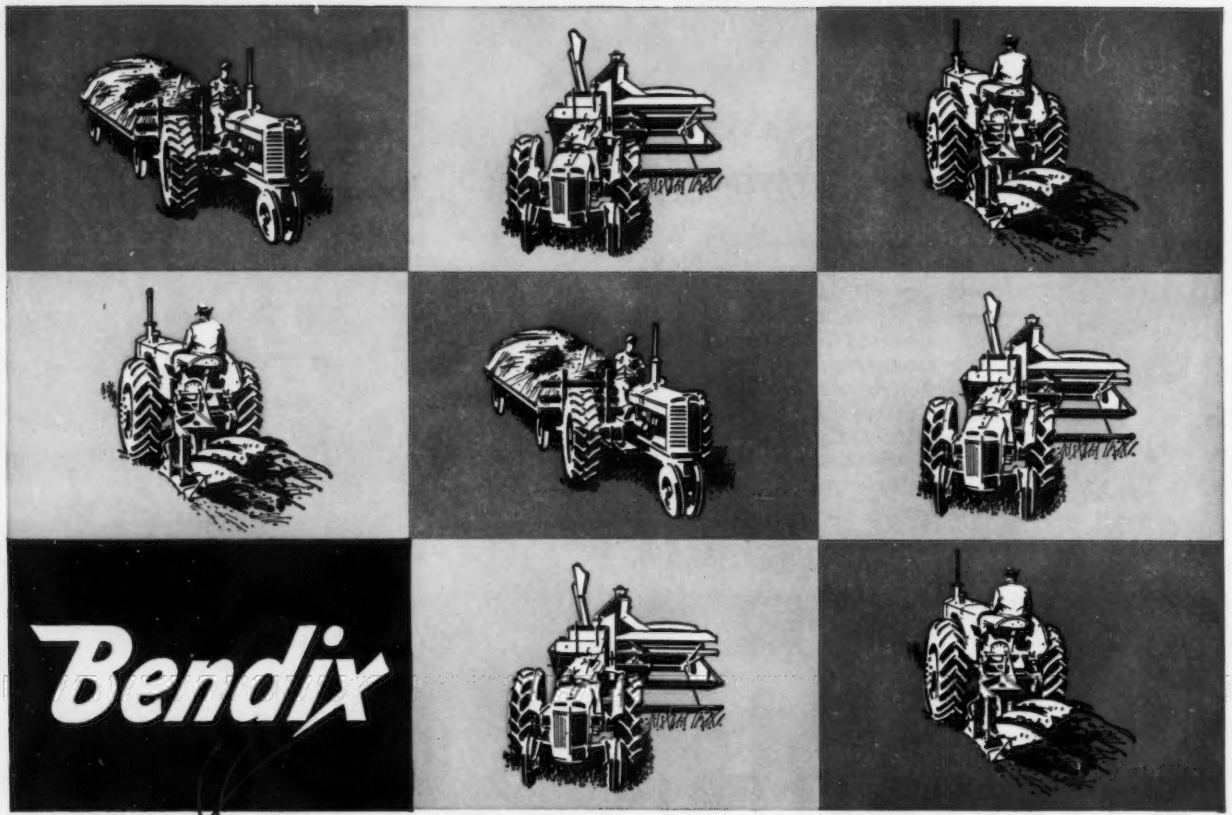
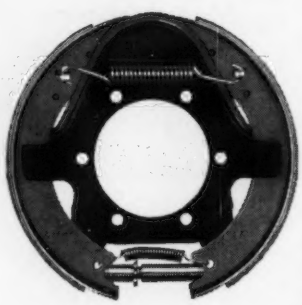
AUTO-LITE

THE ORIGINAL EQUIPMENT LINE



Farm Tractor Brakes...

backed by the greatest name in braking



The Bendix heavy-duty farm tractor brake has powerful and positive holding action in both forward and reverse. Rugged design assures uniform performance day after day, under the most severe field and road work.

For 25 years Bendix has specialized in building brakes for the automotive industry. In that period of time the Bendix Products Division at South Bend has built more than 90 million brakes for passenger cars, trucks and farm tractors.

These are reasons why tractor manufacturers—as well as passenger car and truck manufacturers—look to Bendix as brake headquarters.

Bendix Brakes for farm tractors are specifically designed for the exacting needs of this class of service, combining rugged, dependable and smooth action with low cost. That's why Bendix Brakes are the logical choice for the modern tractor.

Let Bendix farm tractor brake engineers help you solve your brake problems. Write for detailed information.*

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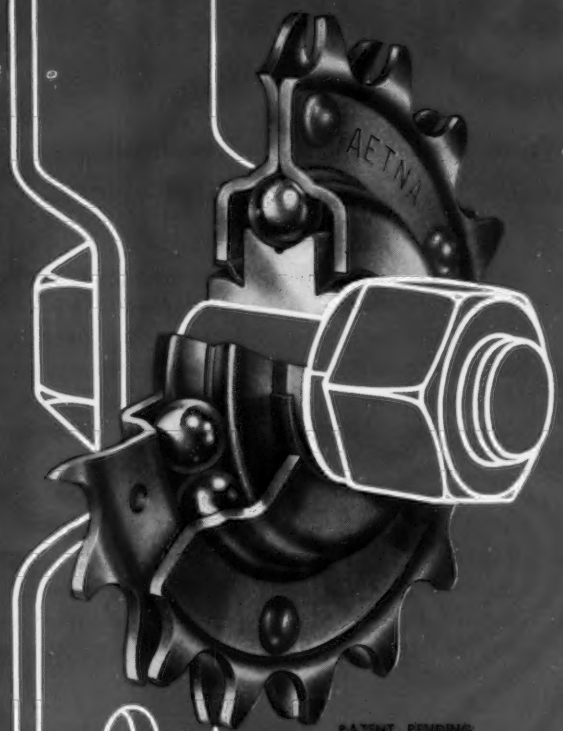
"AG" EQUIPMENT DESIGNERS!

MEET AMERICA'S first BALL BEARING SPROCKET IDLER



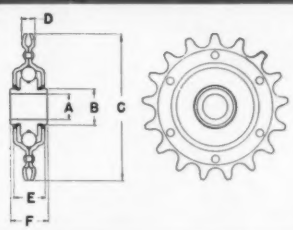
PATENT PENDING

As a farm equipment part SHOULD be:

It's rugged and rigid . . . simple and compact in design . . . inexpensive to buy, to install, to maintain.

Now Aetna engineering ingenuity brings you a sprocket idler and pre-lubricated, sealed, anti-friction bearing—*all-in-one.*

This original and revolutionary, single *package* design permits low initial cost; maximum compactness; easy, speedy assembly line installation. You'll want its pronounced advantages in your new farm machinery designs. In your current models, too! The change-over involves only minor engineering alterations.



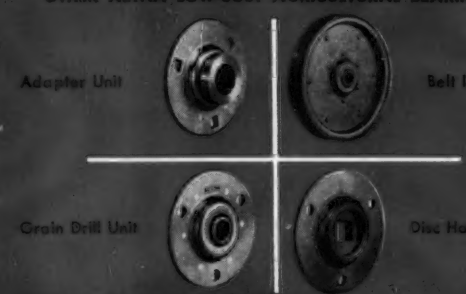
Bearing Number	DIMENSIONS							
	Pitch	Roller Dia.	No. of Teeth	A	B	C	D	E	F
AG-2416	⅜"	.400"	17	⅛"	⅞"	3⅜"	5/16"	.774"	.927"
AG-2416-B	1 ¼"	.400"	9	⅛"	⅞"	3 59/64"	5/16"	.774"	.927"
AG-2417	¾"	15/32"	15	⅛"	⅞"	3 29/32"	7/16"	.774"	.927"
AG-2417-B	1½"	15/32"	7	⅛"	⅞"	3¾"	7/16"	.774"	.927"
AG-2419	1"	.312"	11	⅛"	⅞"	3¾"	¼"	.774"	.927"
AG-2422	1.654"	#62*	7	⅛"	⅞"	4 ¼"	13/16"	.774"	.927"
AG-2423	1.631"	#55*	8	⅛"	⅞"	4¾"	11/16"	.774"	.927"

*Detachable steel chain

Look Into These Features

- Full complement of ⅜" balls for greater capacity. 4-point ball contact for extra rigidity.
- Tripled-capacity lubricant chamber, pre-packed with long-life, water resistant lubricant—no troublesome re-lubrication.
- Dirt-proof, leak-proof, one-piece Buna-N seals (pat. pending) provide self-contouring positive contact; are corrosion and rust-free.
- Sized for use with large ⅜" mounting bolts and with teeth to fit all standard roller and detachable link chain. (Write us about specials.)
- Smoother, quieter operation. As intended by chain designs, the chain rollers work directly on teeth, minimizing chain side bar friction.
- Bearing outer race and sprocket sheave of case hardened, heavy gauge pressed steel.
- Built tough to stay tough . . . for long, trouble-free service on the farm.

OTHER AETNA LOW-COST AGRICULTURAL BEARING UNITS



This new sprocket idler is the latest addition to Aetna's growing line of agricultural anti-friction bearing units. Each is an achievement in quality manufacture to meet today's economy needs. It makes a cost-cutting, problem-solving story that will interest you. Simply mail the handy coupon below.

Aetna

Anti-Friction Consultant To Agricultural Equipment Manufacturers For Forty Years

AETNA BALL AND ROLLER BEARING COMPANY
Div. of Parkersburg-Aetna Corp. • 4600 Schubert Ave. • Chicago 39, Ill.

WITHOUT OBLIGATION...I want to know more about your new line of low-cost mounted bearing units. Please have representative call.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

V-Belt drives protect high

New Rotary Cutter, designed by Wood Bros. Mfg. Co., Oregon, Ill., employs Dayton B.S.I.* V-Belts to neutralize shock, increase efficiency.

Cutting as wide a swath into the affections of farmers across the land as they do in their cover crops, brush, weeds, grass and stalks, Wood Bros.' Rotary Cutters and Mowers are fast becoming a *must* on every farm. Mainly responsible for this enthusiastic acceptance are the high speed blades, which rotate at speeds up to 1500 RPM, delivering a terrific cutting and shattering force efficiently and economically.

Driving the forged and heat-treated alloy spring steel blades are three sturdy Dayton B.S.I.V-Belts. In addition to transmitting every ounce of power from the power take-off, Dayton drives absorb and neutralize the shock load of cutting and shredding and thus *protect* both blades and machine from costly damage, keep maintenance at an absolute minimum.

And, whether the cutting or mowing chore involves fine grass, pasture, tangled brush as thick as your wrist or shredding and mulching corn stalks, Dayton B.S.I. V-Belts take it in stride to help assure continuous, dependable peak performance on every job.

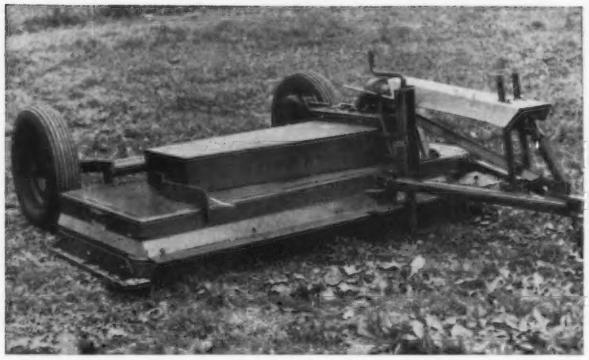
Designed for low cost operation, every Wood's Rotary Cutter and Mower is a multi-purpose implement that brings new speed and thoroughness to shredding, mulching, cutting and mowing. Overlapping blades (on all twin and triple blade models) guarantee a cleaner, closer, more desirable cut. Makes plowing easy, too, once a

speed mower & cutter blades

Wood Bros. Rotary Cutter has cleared the land. Simple, sturdy construction insures continuous service with less sharpening and maintenance needed.

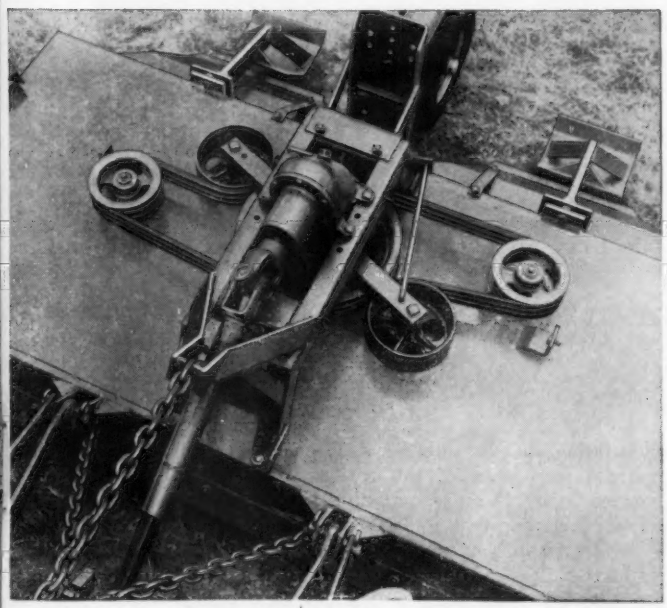
Wood's Cutters and Mowers handle 42″ to 114″ swath with ease!

Nine multi-purpose models offer a complete cutting and mowing range width of 42″ to 114″ to fill every need from small or large orchards and farms to cemeteries, railway rights-of-way, golf courses, airports and factory grounds. Easily adjusted, the Dayton V-Belt driven steel blades can be raised or lowered from ground level to 14″. For complete protection to equipment and operator alike the whirling steel blades are covered with 3/16″ boiler plate. All other moving parts are well protected from weather and terrain hazards by rugged construction and the use of heavy-duty materials.



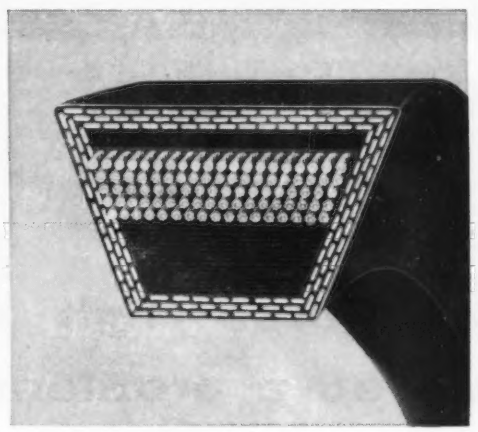
Offset Model 080

For shredding prunings and mowing in orchards and groves, Wood Bros.' new offset Model 080 is ideal. Equipped with twin blades, rotated at 1300 RPM by Dayton B.S.I. V-Belts, the 080 is highly maneuverable and offers close-in cutting because of its offset design in crowded areas. A 3 blade cutter is also available.



Powerful Dayton B.S.I.* V-Belts provide smooth, sure cutting and mowing.

The triple V-Belt Drive, exclusive with Wood Bros., provides a constant source of maximum power. Idler pulleys maintain the exact amount of tension needed to drive single, double or triple blade operations. Dayton B.S.I. V-Belts are particularly suited to rugged requirements, such as this, and deliver long, continuous service for smooth, clean-sweep cutting.



Dayton Agricultural V-Belts for Every Application

For the greatest efficiency, dependability and economy on farm implement drives, more and more manufacturers, like Wood Bros., are turning to Dayton V-Belts for every application. For any V-Belt drive problem, contact your Dayton Agricultural Sales Engineer or write Dayton Rubber Co., Agricultural O.E.M. Division, Dept. 403, 1500 S. Western Ave., Chicago, Ill.

GOLDEN JUBILEE

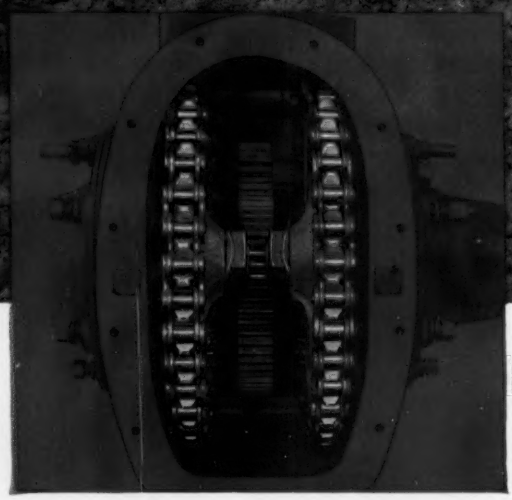
Dayton Rubber 50 YEARS OF PROGRESS

First in Agricultural V-Belts

Agricultural Sales Engineers in Chicago, Moline, New York, San Francisco, Atlanta and St. Louis

© D.R. 1955

*T. M.



When the J. I. Case Company decided to bring the benefits of diesel power to their largest tractor unit, they needed a final drive to transmit high horsepower, to withstand severe chordal action and high shock loading, and most important—to be compact enough to fit within the rigid limits set for the transmission case.

Exhaustive field tests showed that a 2″ pitch Morse High Endurance Roller Chain was ideally suited to the job.

How Morse High Endurance Roller Chain solved a problem on big diesel tractor

Perhaps you, like the J. I. Case Company, have a design problem which can be solved by using Morse High Endurance Roller Chain. If you have increased power transmission requirements, don't change your design . . . check the possibilities of High Endurance Roller Chain to meet your higher power requirements.

Morse High Endurance Roller Chain is the finest available. It is built with particular attention to (1) wear life between bushing and pin; (2) pin retention; (3) bushing retention; (4) impact resistance of the rollers; (5) structural fatigue resistance strength of the plates.

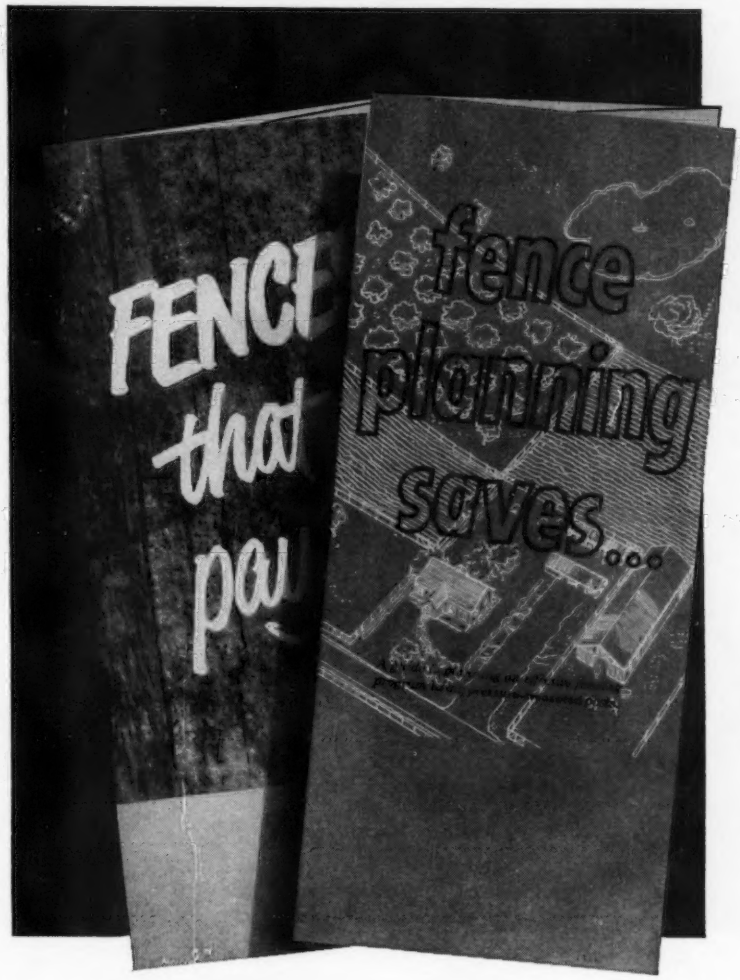
Add to this the factors of fine-grain alloy steel, precision manufacturing, shot peening, and strict quality control —and you have some of the reasons Morse High Endurance Roller Chain is outlasting standard roller chain on some applications by 100% or more. By simply changing the chain, you can realize important savings.

Check Morse High Endurance Roller Chain. Check, too, the other lines of precision-built Morse Power Transmission Products: Roller Chain, Stock Sprockets, Couplings, Cable Chain, and Clutches. Write for further information; Morse engineers will be happy to discuss your power transmission needs with you. MORSE CHAIN COMPANY, INDUSTRIAL SALES DEPT., ITHACA, NEW YORK.

MORSE

CHAINS, CLUTCHES AND COUPLINGS

How To Build Better Farm Fences ...with PRESSURE-CREOSOTED WOOD!



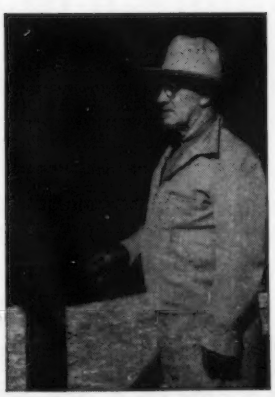
FENCING for the average farm or ranch is an important investment. To help you promote good fencing among the farmers and ranchers in your area United States Steel has made available two free publications. One, "Fences That Pay," tells how to erect fence using pressure-creosoted posts. It covers the spacing, size and setting of posts, and many other good fencing features. The second folder, "Fence Planning Saves," supplies complete information on efficient field and pasture layout and illustrates the money-saving advantages of using pressure-creosoted posts and poles.

There are many good reasons why farmers and ranchers in your neighborhood will be glad they used pressure-creosoted fence posts for their fields and pastures. Many records show that these posts last up to seven times as long as untreated ones. And there is no better wood preservative on the market than USS CREOSOTE. Fence posts pressure-treated with USS CREOSOTE resist damage by weather, adverse soil conditions, and attack by termites, fungi, and other wood destroyers. They cost no more to install than regular posts, and the additional cost of pressure-creosoting is many times offset by the years of longer wear, freedom from repair and replacement.

Keep all these pressure-creosoting advantages in mind when you are discussing fencing with farmers and ranchers. And be sure to send for a free supply of these two informative booklets. They will prove very helpful to anyone planning a new fence installation.

HERE'S what one farmer says about creosoted fence posts. "I operate on a 580-acre farm," says J. Grady Kauffman, Princeton, Missouri, "and have good white oak post timber which has an average life of 8 years. When the cost of labor and the frequency of replacement is considered, their use is almost prohibitive. I am now using pressure - creosoted posts."

UNITED STATES STEEL
USS
CREOSOTE



Send in this coupon NOW!

Agricultural Extension
United States Steel Corporation, Room 4687
525 William Penn Place, Pittsburgh 30, Pa.

Please send me a supply of your two free folders, "Fence Planning Saves" and "Fences That Pay," for distribution to farmers and ranchers in this area.

Name .....

Address .....Town .....

County .....State .....

UNITED STATES STEEL

Can You Find the Solution to a Chain Problem?

If you need help to find the answer to the chain problems of equipment design, the complete CHAIN Belt Line of agricultural implement chains has your economical answer.

Because CHAIN Belt has always stayed abreast... even ahead of your needs... you can find the answer you want in this complete line. And, CHAIN Belt engineers are constantly studying chain application problems of agricultural implements. Many new developments have been completed... more are under way.

Why not be sure you have the up-to-date solutions for your chain problems? Consult your CHAIN Belt District Sales Engineer or write CHAIN Belt Company, 4680 W. Greenfield Ave., Milwaukee 1, Wis., for your copy of Agricultural Chain Catalog No. 54-54.

CHAIN BELT COMPANY

District Sales Offices in all principal cities

Modern manure spreaders are p. t. o. driven through

BLOOD BROTHERS Jointed Drive Lines

for better control . . .
better distribution . . .
better crop returns . . .

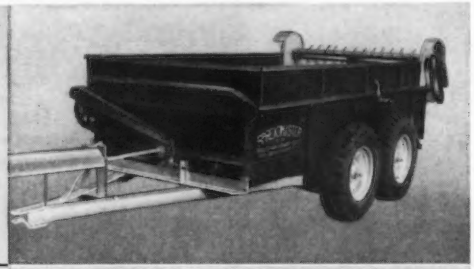
Knight Mfg. Company

New Holland Machine Company

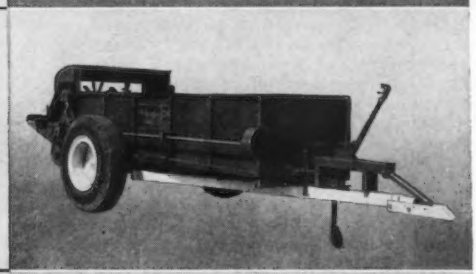
New Idea Farm Equipment Company

The Oliver Corp.

L. H. Shultz Mfg. Company



United Implements Inc.



The Farmhand Company

Kelly-Ryan Company

Compared with older drive mechanisms, the modern p.t.o. powered manure spreader provides easier operator control, for more even spread of volume desired at various speeds.

And in designing these up-to-date spreaders, each implement builder logically specified Blood Brothers Universal Joints and Drive Lines.

As the "Standards of the Industry," they assure the trouble-free, long-lasting service that farmers expect.

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED.

also The Cobey Corp. (not shown).

TAKES POWER AROUND CORNERS

BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

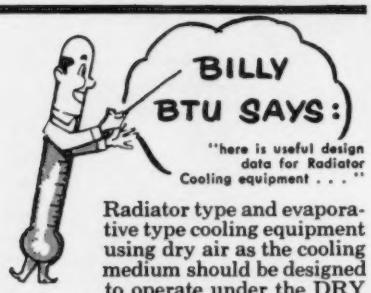
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Young Heat Transfer News

YOUNG RADIATOR COMPANY, RACINE, WIS.

Allis-Chalmers *SPECIFIES* Young Radiators for models CA and WD-45 Tractors



Radiator type and evaporative type cooling equipment using dry air as the cooling medium should be designed to operate under the DRY BULB air temperatures to be expected during the summer in the locality where the equipment is to operate. Equipment using cooling effect due to water evaporation is designed to operate under the WET BULB air temperatures to be expected.

For proper design, it is not satisfactory to use either the maximum air temperature, nor the average air temperature. Use of the maximum air temperature for design would result in the selection of cooling equipment too large to be economical, since it would be fully loaded only under the most extreme temperature conditions. Use of average temperature for design purposes would result in selection of equipment too small to handle the cooling load during a great portion of the operating time. It is necessary, therefore, to use some figure between maximum and average air temperatures.

The Young Radiator Company has prepared and offers to engineers engaged in the design and application of radiator type and evaporative type cooling equipment, data taken from the results of five years of summer records in the United States. This data may be used and considered as applying to an average year.

For a copy of this data, write for Bulletin 654, Young Radiator Company, Racine, Wisconsin.

WRITE FOR FREE DESIGN TEMPERATURE BULLETIN OF THE UNITED STATES

Helpful four-page Bulletin briefly discusses atmospheric cooling equipment design temperatures for the United States. Wet and dry bulb maps are fully illustrated with isothermal lines. Write Young Radiator Company, Dept. 295-D, Racine, Wisconsin.

Drawn Tank Radiators Meet All Tractor Cooling Loads

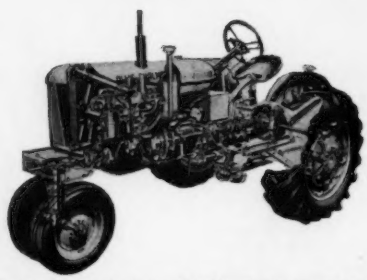
Allis-Chalmers Manufacturing Company, West Allis, Wisconsin, uses Young Radiator Company drawn tank Radiators on two powerful tractor models.

Built to withstand the constant strain and stress put upon tractors, these Young units must cope with high internal water impact pressures due to sudden starting and stopping.

To overcome these and other torsional stresses and long term vibrations, full wrap-around type terne plate side members secure tanks, headers and core as one piece. Brass top and bottom tanks are formed as one piece and have die-formed beads for reinforcement. Fabricated brass inlet with maximum flow area provides minimum resistance to coolant circulation.

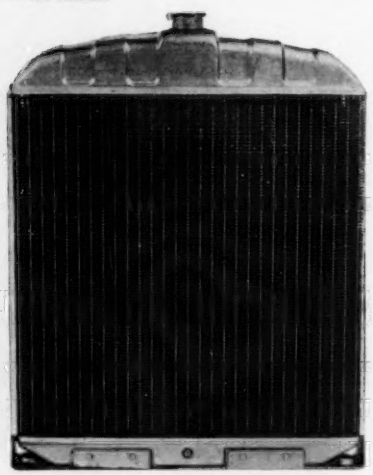
This Radiator also features Young patented double-grip, two-way headers with lapped joint solder sealed to tanks as a permanent, leak-proof assembly. Fully soldered double-lockseam tubes with corrugated fins makes for strength and maximum air turbulence and greater heat transfer.

For further details, write dept. 295-D, Young Radiator Company, Racine, Wisconsin.



Cross-sectional view of Allis-Chalmers Model WD-45 Tractor with Young Radiator.

View of Allis-Chalmers CA Tractor and forage harvester making grass silage.



Young Radiator Company drawn tank Radiator used on Allis-Chalmers Model CA Tractor.

Young RADIATOR COMPANY

RACINE, WISCONSIN

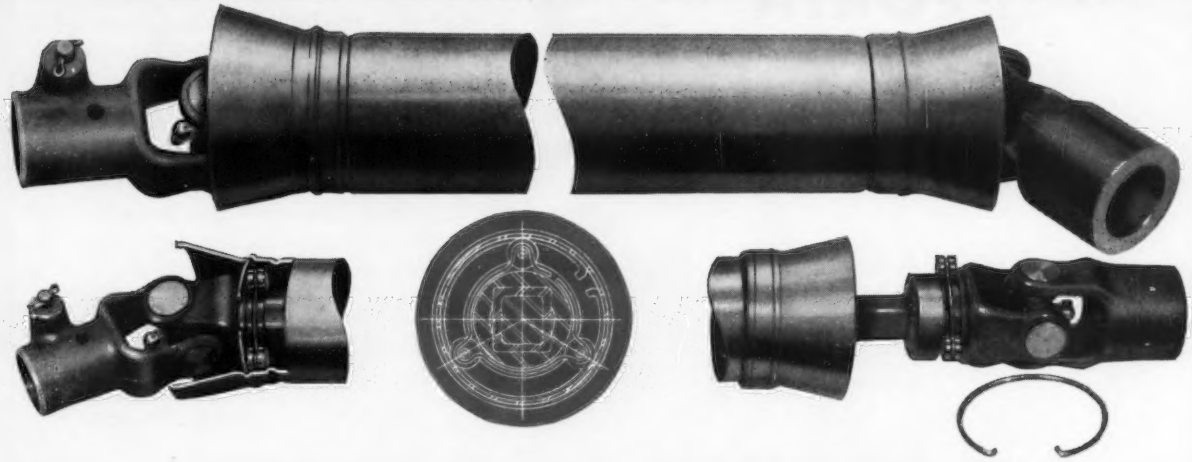
Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

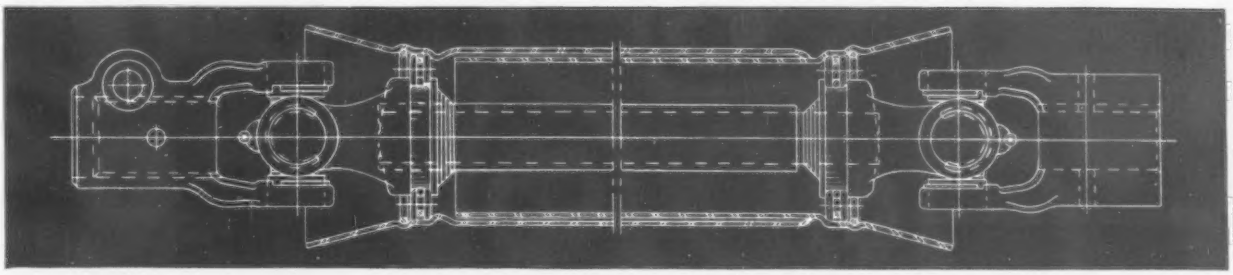
Heat Transfer Products for Automotive, Aviation and Industrial Applications.

Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

Complete Protection — Stronger Construction Lighter Weight — CAN BE SERVICED





This NEW type MECHANICS SAFETY SHIELD solves many operating problems, because:

1 — True roller bearings run between raceway on joint and collar in shield. Rollers are held in place by a snap ring.

2 — Shield more completely covers joints — for complete protection.

3 — No welds in shield — leaving longer over-lap of shield tubes (with same length shaft) for greater strength.

4 — CAN BE SERVICED by operator, with only a screwdriver.

5 — Shield can be removed, to service joints.

6 — Open construction, with LARGE rollers, permit dirt to fall out.

Write for information about sizes, joint types, etc.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2046 Harrison Ave., Rockford, Ill.

MECHANICS
Roller Bearing BW
UNIVERSAL JOINTS
For Trucks • Tractors and Farm Machines

PEORIA MALLEABLE CASTINGS

ARE

PART OF

THE

ALLIS-CHALMERS

PICTURE

Allis-Chalmers – a famous name in farm equipment, tractors and earthmoving equipment – is another in the list of leading manufacturers who use Peoria Malleable castings in their products.

Peoria Malleable castings have earned the confidence placed in them. They are quality parts – long lasting and good looking. And very often they cost less than the material and labor involved in manufacturing a part as a weldment or a forging.

Send a letter for further information – or send specifications for a definite quotation, at no obligation.

A big part of **QUALITY** *is a* **QUALITY** *part*

STANDARD OR PEARLITIC

PEORIA MALLEABLE CASTINGS CO.

FT. OF ALEXANDER ST., PEORIA, ILLINOIS

FAMOUS FOR **QUALITY**

Allis-Chalmers HD-9 diesel crawler tractor cultivates ground with Allis-Chalmers 5-point chisel attachment for the Oxnard-built tool-bar carrier.

It's a *Brand New* Utility Tractor *with 2-Row Planting and Cultivating*

It's here—the new John Deere "40" Utility Two-Row, the tractor which not only incorporates all the universally accepted features of its companion model, the John Deere "40" Utility, but can also be used for planting—in two rows—corn, cotton, peanuts and similar crops.

The big "plus" advantage of the "40" Two-Row, of course, is the front-end cultivating feature which means that the operator can "keep his eye on the work" and be sure of a cleaner, speedier, thriftier cultivating job. Moreover, the "40" Utility Two-Row is a well-balanced, all-around tractor—a natural for mowing, hauling, and seedbed making, equally at home in orchards, groves, and on sloping fields. Other features include John Deere 3-Point Hitch, Dual Touch-o-matic with Load-and-Depth Control, and variable front and rear wheel spacing.

Naturally, there are certain qualities that this new tractor has in common with all John Deere equipment, including the expert craftsmanship and the consistently high quality of the materials which have gone into its construction.

JOHN DEERE QUALITY FARM EQUIPMENT

JOHN DEERE · **MOLINE ILLINOIS**

QUALITY FARM EQUIPMENT SINCE 1837

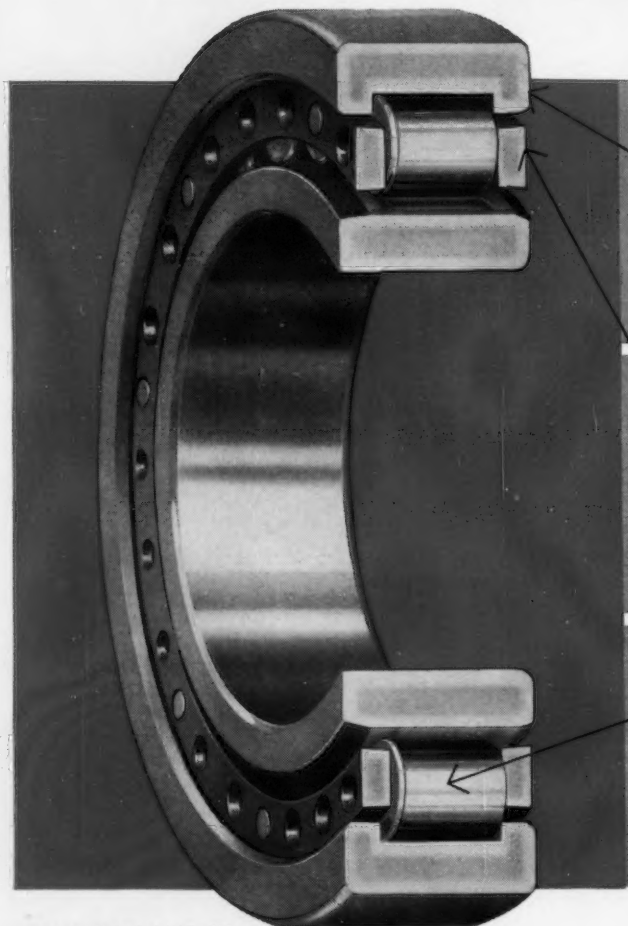
Here's why BOWER straight roller bearings can carry maximum loads—with less maintenance!

The important design features of Bower straight roller bearings shown on this page are just a few of the reasons why these bearings will operate efficiently and economically in your product. Consider these facts, too. Bower straight roller bearings incorporate highest quality materials and workmanship. They have proved themselves capable of standing up day in and day out under maximum loads—with little or no maintenance.

In fact, this is the reason why Bower straight roller bearings are used extensively by leading manufacturers in such fields as automotive, earthmoving, farm equipment and machine tool.

Let a Bower engineer give you full details of the complete Bower line. Call him in while your product is still in the blueprint stage.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN



● ***TWO-LIP RACE INCREASES RIGIDITY.*** These two shoulders, made parallel, are integral with the outer race. This provides a more rigid, durable construction. Rollers are kept in proper alignment at all times.

● ***COMPOSITE STEEL CAGE DOES NOT CONTACT ROLLERS DURING NORMAL OPERATION,*** thereby allowing free movement of the rollers between the races. Projections on the inner faces of the rings engage indentations on the roller ends preventing the rollers from dropping out of position when the separable race is removed.

● ***PRECISION-BUILT ROLLERS AND RACES ARE MADE TO SUPPORT MAXIMUM RADIAL LOADS.*** Only the highest grade steel-alloy is used, and rollers and races are precision ground to give quieter, smoother operation. Running clearance is built in at the time of manufacture.

A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER

ROLLER BEARINGS

SPHER-O-HONED

MORE EFFICIENT DESIGN, IMPORTANT SAVINGS, SIMPLIFIED ASSEMBLY, BETTER APPEARANCE

THESE ARE SOME OF THE MANY BENEFITS reported by agricultural equipment engineers who have applied TRU-LAY PUSH-PULLS for remote control operations on a wide range of agricultural implements

Here are typical comments recently received from equipment manufacturers whose machines or implements are equipped with these accurate and dependable remote controls:

Saves Time, Labor and Material
"The use of your flexible Push-Pulls saves us a great deal of time, labor and material. The old linkages frequently required much planning in both engineering and shop which is not required now. On some of our equipment we use Push-Pulls from 10 to 30 feet in length. They operate clutch controls on the Main Power Unit, Feed Conveyors and Delivery Conveyors."

Greater Flexibility of Design
"The principal advantage of Tru-Lay Push-Pulls in our application is that they permit flexibility in locating the control valve in relation to the operator's position."

Cost Less to Install
"Tru-Lay Push-Pulls are easier and less expensive to install than linkages for remote control of power take-off, brake and clutch. Better appearance, too."

Simple and Neat
"For several models of farm tractors, we selected your controls for their simplicity and neatness of application as governor controls."

Solution to Tough Problem
"Can be installed where straight rods are impossible . . . for Remote Control of transmissions, brakes and clutches."

Eliminates Maintenance
"Simple operation and elimination of maintenance problem are the major advantages in using your Push-Pulls."

Reduces Number of Parts
"Your Push-Pulls have eliminated links, radius rods and other lost-motion devices for remote control of hydraulic valves."

Provide ACCURATE Control
"Tru-Lay Push-Pull control cables provide minimum back-lash, even in installations up to 30 feet in length, because the cable is designed to close tolerances with minimum drag and lost motion."

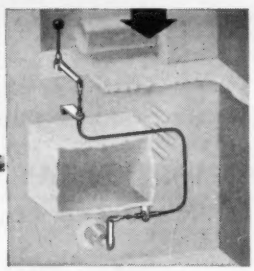
• • •

TRU-LAY PUSH-PULLS are "Solid as a rod but *Flexible* as a wire rope." This flexibility makes it possible to snake around obstructions . . . permits the ideal arrangement of all elements of remote controls.

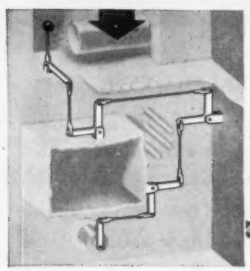
Advantages *of Tru-Lay Push-Pull flexibility and simplicity are pictured below—*

TRU-LAY PUSH-PULL

Simple
One Moving Part
Life-Time Service
Life-Time Accuracy
Low over-all Cost
Noiseless



MECHANICAL LINKAGES



Complex
Many Parts
Many Points of Wear
Increasing Back-Lash
Loss of Accuracy
Vibration
Rattles

• Engineers have adopted these accurate and dependable remote controls for use on a wide range of agricultural equipment . . . tractors, combines, corn pickers, corn detassler machines, corn row sprayers, orchard sprayers, tobacco picking machines, power-driven tree trimmers, and others.

Tru-Lay Push-Pulls are used for the remote control of transmissions, hydraulic and air valves, brakes, clutches, throttles, chokes, governors, power take-offs, spray nozzles, vent directional fins and on many other applications.

The six bulletins and booklets in the DATA FILE will answer all your further questions

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There is No Worry about Failures or Maintenance Costs with TRU-LAY Push-Pull Remote Controls

Long Life is a matter of record. We have never heard of a Tru-Lay Flexible Push-Pull Control wearing out in normal service. Failures, that sometimes harass users of more complex controls, are eliminated by the use of these simple, positive-action controls.

Dependable Operation of these controls is a certainty, even under the most adverse conditions . . . HOT as jet engines (note: Tru-Lay Push-Pulls are actually performing on hot jet applications) . . . COLD to 70° F below zero . . . SOAKIN' WET . . . ABRASIVE . . . or just plain TOUGH.

Freedom from Trouble is assured because of such features as . . . full protection of the inner, working member by the tough flexible conduit . . . lubrication of the inner, working member *for life* during assembly . . . seals that keep moisture, dust and other foreign matter out of the unit . . . cold swaging of fittings that makes them integral parts of the control unit.

Accuracy is inherent in the basic design of Tru-Lay Push-Pulls. They are precision products, not gadgets.

Capacity ranges from light jobs up to jobs of 1,000 lbs. input. These Push-Pulls will handle jobs 150 feet or more from the control point.

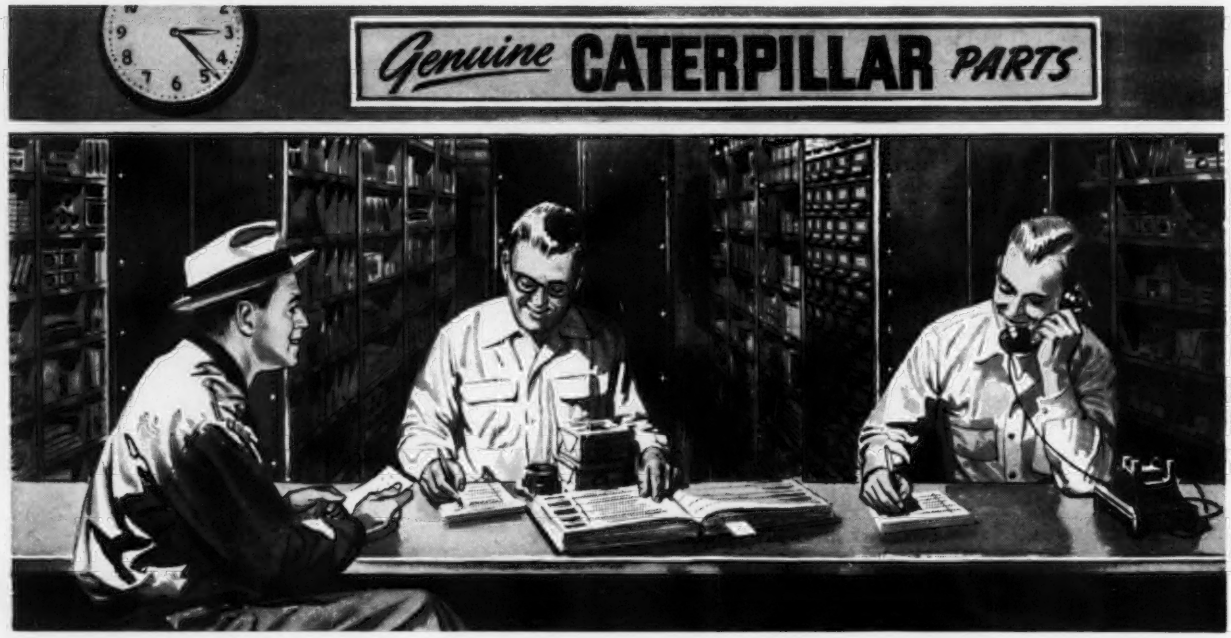
"Solid as a rod, Flexible as a wire rope" aptly describes Tru-Lay Push-Pull Controls. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . it greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Adaptability to all sorts of mechanical situations explains, in large measure, the wide-spread application of Tru-Lay Push-Pulls. Standard anchorages, fittings and heads have been designed that meet requirements on approximately 80% of the installations. Simple modifications of these standards, or minor changes in your own design, cover almost every special situation. Our engineers have the know-how on such matters, and will work with you.

For Further Information see our catalog in Sweet's Design File, write us for the DATA FILE described at the left, or ask to have a sales engineer call.

"Over 80% of our parts orders come to us by Long Distance telephone"

Whayne Supply Co.
Louisville, Ky.



How much does tractor "downtime" cost on the job?

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Over 80 per cent of Whayne's parts orders come in from customers by Long Distance. In rare cases, where a part is temporarily out of stock, Whayne telephones other sources of supply within 300 miles *at no cost to its customer.*

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Des Moines to Minneapolis	85¢
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AGRICULTURAL ENGINEERING

VOL. 36 APRIL, 1955 NO. 4

Semi-Self-Propelled Harvesting Machine

R. W. King and B. G. Elliott
Member ASAE

Engineers develop a new concept in self-propulsion applicable not only to a single machine but to a family of machines

THE great migration of farm workers from the farms to factories at the beginning of World War II left the farmer shorthanded at a time when he needed to produce the most. This situation created a demand for the self-propelled combine, and ultimately the self-propelled corn picker, forage harvester, etc. These machines had been designed primarily for use on large acreages, but with the shortage of farm labor and high farm prices the market for them expanded far beyond what had been anticipated. The small farmer, who originally had not been considered a prospective buyer, suddenly became a good customer.

The war years were lush years for the farmer and machinery was scarce. Consequently, he bought practically any machine he could get and at almost any price. These years, however, had clearly established the great operating economy and convenience of the self-propelled harvesting machine. Realizing that the small farmer could not, under normal conditions, afford the large, self-propelled machines, the farm machinery manufacturers began to develop equipment to reach this large potential market of small farmers. Our company recognized the importance of this market and embarked on a program of development aimed at bringing the advantages of the self-propelled harvesting machine to the smaller farmer at prices he could afford.

The first and oftentimes the hardest step in any new program is to evaluate the problem and outline the requirements. Stated in simple terms, our problem was to develop a line of power-harvesting machinery with all the advantages of the self-propelled machine but without the high cost.

A brief analysis of the self-propelled machine showed that its most costly components are the transmission, the differential, the power plant, and the steering mechanism. If we eliminated these, of course, we no longer had a self-propelled machine. All of these components, however, are available in any tractor. Would it not be possible to utilize the farmer's basic machine—his tractor—as the source of power and as the propelling and guiding vehicle, by integrating it with a suitably designed harvesting machine so that the advantages of maneuverability, visibility, and convenience of controls of the self-propelled machine would be realized? We decided this method of attack gave promise of the most economical solution of the problem.

The basic idea of a harvesting machine, integrated with the tractor is of course not new. Our hope, however, has been to carry the idea further than it has been in the past, to the extent that a whole series of machines would be developed having common mounting and operating characteristics and allow utilizing the farm tractor, basically unmodified, as the prime mover.

Once having made this basic decision, the development program could be broken down into three major problems. It should be pointed out at this point, that we are now discussing those particular problems common to a whole family of machines and not the individual mechanisms of the separate harvesting machines. The three major problems are as follows:

1 Placement of the machine in relation to the tractor
   (a) To give the operator a continuous view of the header or pickup without strain or fatigue
   (b) To permit locating all controls within easy reach without cumbersome levers, etc.

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1954, on a program arranged by the Power and Machinery Division.

The authors—R. W. KING and B. G. ELLIOTT—are, respectively, chief engineer and chief project engineer on utility and industrial equipment, Ferguson Division, Massey-Harris-Ferguson, Inc.

Fig. 1 The semi-self-propelled baler

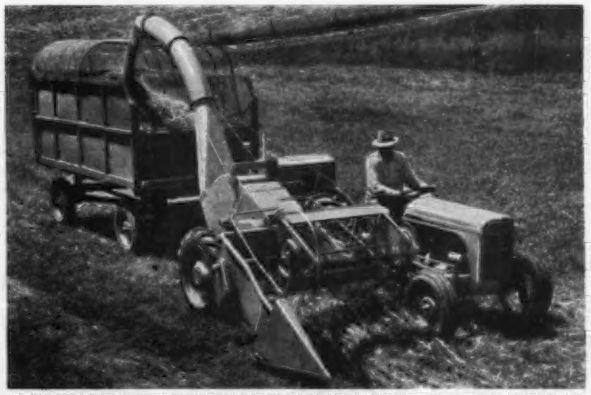


Fig. 2 The Ferguson semi-self-propelled forage harvester with pickup attachment

(c) To achieve a highly maneuverable and compact tractor and machine combination

(d) To take into account the different size, weight and operational requirements of a whole series of machines such as balers, forage harvesters, corn pickers and combines.

2 A rapid method of coupling and uncoupling tractor and machine

(a) To permit one-man hitching without any lifting or straining

(b) To leave the tractor completely and immediately available for any other farm uses when it is unhitched from the machine.

3 Location and mounting of an auxiliary power plant

(a) To permit machine operation with either auxiliary power plant or by power take-off

(b) To permit one man to install or remove power plant and to transport it to any other place on the farm, using only the basic tractor.

To solve these problems which are applicable to a family of machines we found it necessary to begin simultaneously the development of three different harvesting machines. The obstacles were varied and many. The problems of one machine became the problems of all, and many times one machine had to be changed to accommodate some unavoidable condition on the other two machines, or two had to be changed to accommodate one. Looking back now, we are able to appreciate the wisdom of simultaneous development of several machines because it prevented the favoring of any one machine in working out the semi-self-propelled concept. Through the cooperative efforts of the various machine-design groups, and with help and suggestions from practically the whole of the engineering department of our company, we arrived at our conception of a reasonably priced implement with all the advantages of the self-propelled machine. The first of these machines, the baler and forage harvester, are shown in Figs. 1 and 2 and are now in production. We believe the term "semi-self-propelled" adequately describes these new machines.

After considerable preliminary work and testing, a side-by-side mounting of tractor and machine was chosen. Fig. 3 shows the tractor-machine relationship. This seemed the answer to the problems enumerated above with respect to visibility and convenience to the controls, but it presented many new problems as development and testing progressed. As seen in Fig. 3, the visibility from the tractor seat is good. The operator looks forward and watches the header as he drives. Fig. 4 shows how the controls for the forage harvester are all within easy reach of the operator.

Fig.3 The Ferguson semi-self-propelled forage harvester with direct-cut grass header

Compactness and maneuverability were achieved with this side-placement, or side-mounting, by attaching the machine to the tractor at two points. Thus the machine is supported at three points:

1 The rear hook hitch located just under the rear of tractor differential

2 The tractor quick latch located at the side of the tractor at the rear of the engine block

3 The outboard wheel of the implement located approximately in line with the tractor rear wheels.

The side-mounted machine is thus hinged to the tractor about a horizontal axis determined by the line joining the rear hook hitch and the front clevis (or "quick latch" as we have called it). This articulation or hinge action permits the outboard wheel of the machine to rise or fall in relation to the tractor as the unevenness of the ground requires. At the same time, however, the tractor and machine turn and maneuver as though they were rigidly connected.

We have found that proper machine-weight distribution between the outboard wheel and the two tractor hitch points, as required by various harvesting machines of different sizes and weights, can be adequately provided for by proper placement of the outboard wheel. Contrary to what might be assumed at first thought, it has not been found necessary to locate this wheel in line with the tractor rear axle.

The attachment of these relatively large machines to the side of the small Ferguson tractor naturally introduced problems of side draft since the rolling resistance of the outboard wheel tends to pull the tractor to the right. It was found that this side draft tendency varied in degree from one machine to another and according to the terrain and operating conditions. To overcome side draft where it became objectionable on very difficult terrain, we have developed a drive from the tractor right-hand rear axle to the implement

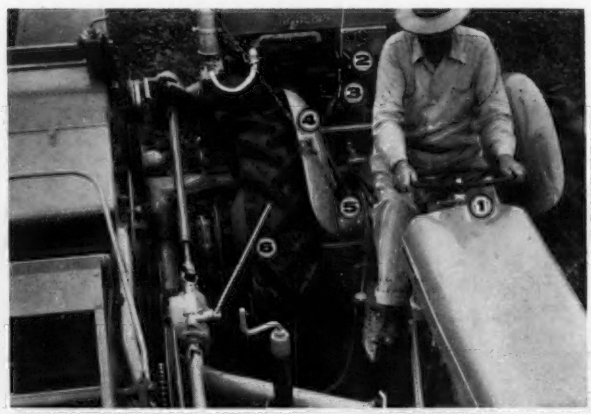


Fig. 4 Table, cylinder, delivery pipe and tractor controls are handy and easy to reach from the tractor seat. The driver can (1) operate all tractor controls, (2) start the auxiliary engine, (3) engage or disengage auxiliary-engine clutch with its automatic engine-throttle control, (4) raise or lower delivery-pipe hood, (5) raise or lower header with finger-tip control lever, and (6) stop or reverse the feed rolls

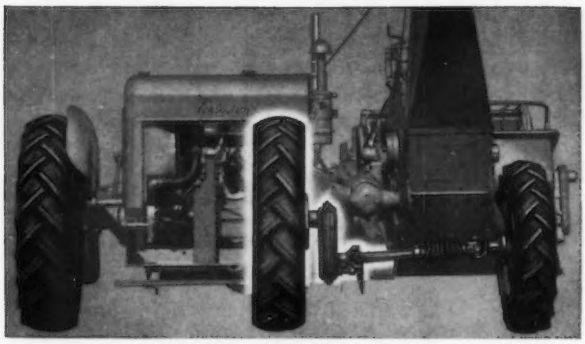


Fig. 5 Forage harvester with outboard wheel-drive attachment

outboard wheel. This is accomplished in the following manner:

The right-hand rear tractor wheel is removed and a stub axle bolted to the tractor rear axle. A freely journaled hub is mounted on this stub axle through two bearings and the tractor wheel remounted to this hub. This results in a live axle extending through the wheel while the right-hand tractor wheel is free to roll and support weight. A quickly removable chain-drive housing is attached to this stub axle. The lower sprocket of this chain drive is attached to a splined shaft which is connected with the outboard-wheel axle by means of a telescoping universal drive shaft. The chain case was, in turn, secured against rotating by a connecting link between it and the implement frame. This general arrangement is shown in Fig. 5. Equipped with this drive, the implement becomes a truly semi-self-propelled machine with the two outside wheels driving and the center wheel, which is the tractor right-hand rear wheel, rolling freely, although carrying its share of the weight. Applying the right-hand tractor brake allows the complete unit to pivot around the implement outboard wheel just as braking of the left-hand wheel pivots the unit around the left-hand tractor wheel.

This drive is not necessary in all conditions. In many cases, both the forage harvester and baler work very satisfactorily without it. With the Forage harvester, it is possible to hitch a wagon to the left of center far enough to offset any apparent side draft.

The special hub for attaching the outboard-wheel drive is equipped with a clutching arrangement, which permits the tractor right-hand rear wheel to freewheel as described above or to be locked to the tractor axle in the normal manner. Thus, when the machine is unhitched from the tractor, the chain case is readily removed and the locking feature of the hub permits the tractor to be used for any other normal tractor work. The design of the clutch is shown in Fig. 6. This locking feature also comes in handy at times when used with the outboard wheel drive. In muddy or sandy conditions, when traction becomes a problem, the tractor wheel may be clutched into gear by rotating the hand lever. This gives three driving wheels and considerably more traction for temporary emergencies. The wheel must, of course, be declutched before making any sharp turns as this eliminates all differential action.

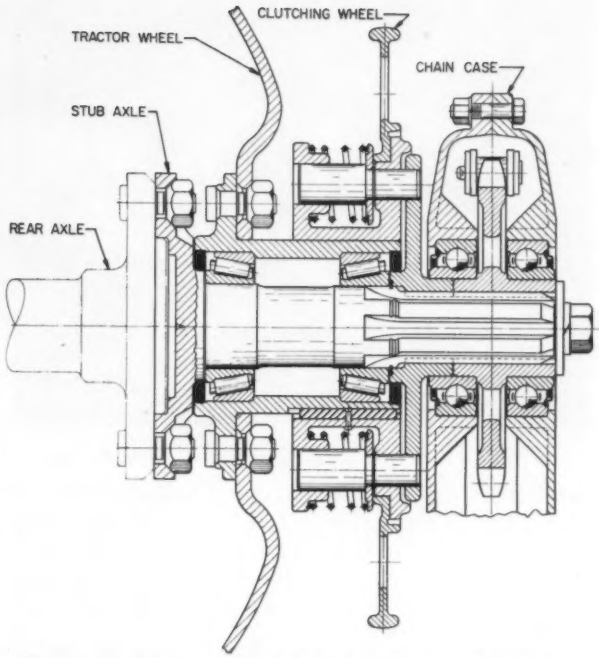


Fig. 6 Cross-section view of outboard wheel-drive hub assembly

Perhaps the most troublesome of all the problems connected with this development was working out a quick and easy one-man method of hitching or coupling the machine to the tractor. We finally overcame this problem through the development of a jackknifing technique as shown in Fig. 7.

The hitching of the implement to the tractor is accomplished in the following manner: The tractor, equipped with a special hook hitch attached to the tractor lower links

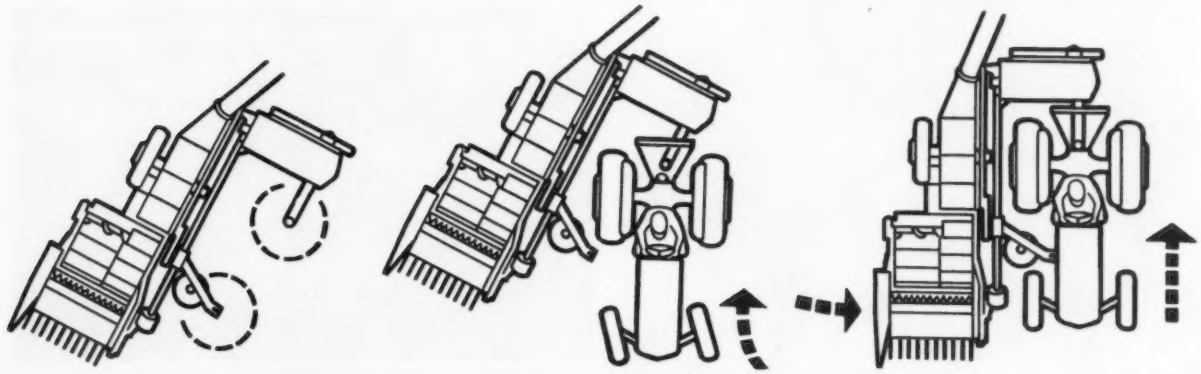


Fig. 7 Diagram showing hitching procedure for side-mounted machines

Fig. 8 The semi-self-propelled baler with power unit

and actuated by the hydraulic control quadrant and with the front quick latch, is backed into the implement as shown in Fig. 7 at an angle sufficient for the right-hand tractor wheel to clear the implement frame. It is backed up until the rear hook, in its down position, is under the rear hitch ring on the implement.

The hydraulic control lever is then moved to its up position, causing the hook to engage the hitch ring. When it reaches its uppermost position a mechanical latch engages, taking the load off the hydraulic system. The tractor is then backed up farther, causing the machine to jackknife into position. As the front hitch enters the front quick latch, it engages automatically. The front stand and the rear caster wheel, which support the machine when it is not connected to the tractor, are then raised and the hitching is complete. The front stand is provided with a dished circular pad or foot-piece to permit it to slide, even in soft ground, during the jackknifing operation. The pad is also adjustable in height by means of a handscrew crank to take care of ground unevenness. The forage-harvester header is controlled hydraulically and, when hitching it, the hydraulic hose is connected to the tractor system by a quick coupling.

The total hitching operation can be readily accomplished in two minutes or less with very little practice.

If the outboard-wheel drive is used, the chain case is placed on the stub axle before the tractor is backed into the machine as described above. After the machine is hitched, the universal drive shaft is connected between the chain case lower shaft and the outboard wheel, and the connecting link is attached between the chain case and the implement frame. The use of the outboard-wheel drive adds about one to two minutes to the required hitching time.

The development of an auxiliary power unit was an item of major consideration in this program, since our semi-self-propelled system was designed around the small Ferguson tractor. Although the baler and other machines under development can be operated very satisfactorily by power take-off, the forage harvester requires an auxiliary power unit for work in heavy crops and on very hilly or difficult terrain.

Since our primary aim was to keep the cost down without sacrificing operating efficiency, quality of construction, etc., it was apparent that one power unit must serve all machines and be quickly and easily transferable from one machine to another.

After a great deal of preliminary development work, a simple solution was arrived at by utilizing the Ferguson three-point linkage and hydraulic system to pick up and carry the power unit. The unit is mounted on the machine frame at the rear of the tractor as shown in Fig. 8. The same brackets on the harvesting-machine frame, which support the power unit, are also used as mounting points for the belt sheaves used when driving the machine by power take-off. The PTO belt arrangement for the baler is shown in Fig. 9.

The power unit is provided with its own stand or frame which, in turn, is equipped with suitable hitch points for receiving the tractor linkage. It may be transferred from one machine to the other in the following manner:

- Disconnect the quick-coupling power shaft
- Remove the four bolts attaching power plant frame to harvesting machine
- Connect the tractor rear links and lift with the hydraulic system of the tractor (Fig. 10).

This transfer should require a maximum of five minutes. This allows one power unit to do the work of many. As well as being useful in transferring the power unit from one machine to another, this system provides an easy method of transporting it to other jobs around the farm, such as driving a supplementary irrigation pump, grinding feed, etc. It might, in certain instances, eliminate the need for a second tractor.

(Continued on page 241)

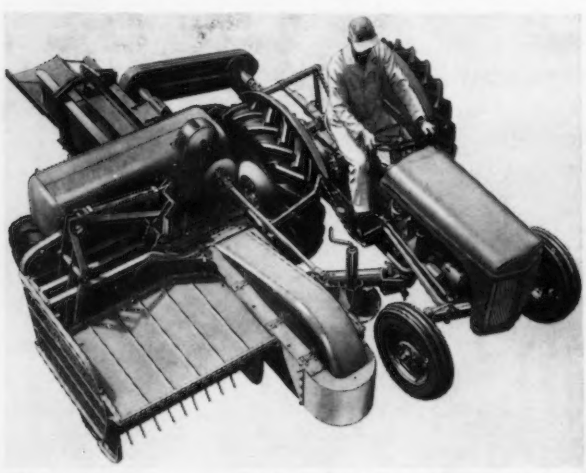


Fig. 9 The Ferguson semi-self-propelled baler with power-take-off drive

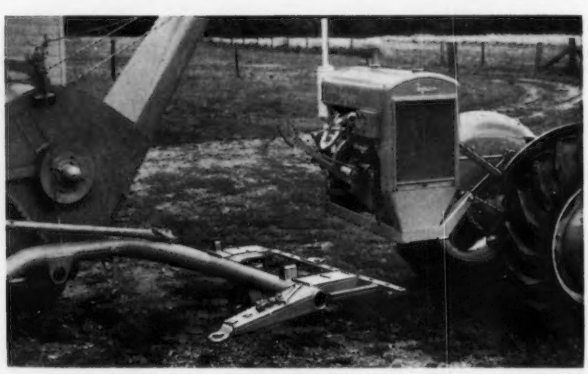


Fig. 10 Power unit being removed from forage harvester by lifting with tractor linkage

Rigid-Pillar Construction

LeRoy W. Bonnicksen
Assoc. Member ASAE

A RIGID pillar is a column which is fixed at its lower support. Rigid-pillar construction is where the frame of the building is made of columns with at least one column being a rigid pillar and the remainder of the building frame fixed or hinged to the column or rigid-pillar tops, and sides. (See Fig. 1 for illustrations of bents using rigid pillars.) The moment forces exerted on the bents are resisted entirely by the lower joints of the rigid pillars or in combination with the rest of the structure.

When only the rigidity of the lower joints is used for bracing, rigid-pillar construction offers its main advantages which are as follows:

1 No bracing in any direction is required in the remainder of the structure, thus permitting a clean design with a high degree of freedom of passage.

2 Because only hinge attachments are necessary, the roof and walls could be designed so that they will be simple and easy to attach to or detach from the pillar.

3 The building could be designed so that it can be built by installments.

4 The roof and walls could be designed so they can be assembled on the ground and raised into place.

When bracing is used on the tops of the pillars, rigid-pillar construction can also offer the following advantages:

1 The combination of the lower rigid support and top bracing can give a building a high degree of rigidity.

2 If top bracing is needed, it does not have to be as elaborate when the lower support is rigid as when it is hinged.

There are limitations to rigid-pillar construction, but ways can be found to overcome them:

Paper presented at the 47th annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Farm Structures Division. Approved for publication as Research Report No. 4 by the Director of the Oregon Agricultural Experiment Station.

The author—LEROY W. BONNICKSEN—is assistant professor of agricultural engineering, Oregon State College.

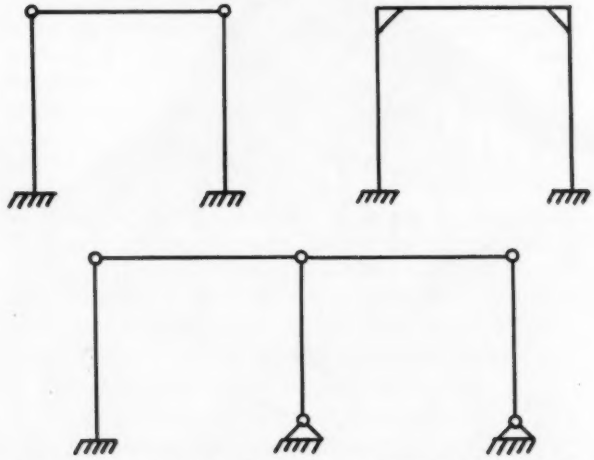


Fig. 1 Bents using rigid pillars. *(Top left)* Structure hinged to tops of rigid pillars. *(Top right)* Structure fixed to tops of rigid pillars. *(Bottom)* Combination rigid pillar and hinged columns. All moments are resisted by the lower support of the rigid pillar

A type of building construction that can be designed for easy erection by farmers or for mass erection

1 In rocky, gravel, or hard soils, holes are difficult or impractical to dig. This can be overcome by using a shallow, widespread footing to which the pillar is made rigid.

2 The deflection of the top of the pillar, when subjected to horizontal forces from wind or uneven loading, may be undesirable. This is similar to a tree swaying in the breeze. If the structure is properly constructed and hinged to the pillar, this deflection should be of no harm. However, if it is not desirable to have this deflection, it can be overcome by increasing the number of rigid pillars, stiffening the pillars or increasing the rigidity of the lower supports. Additional bracing can be used to overcome the deflection of the pillars, if it will not interfere with the freedom of passage or can be used to increase the load-carrying capacity of the structure.

3 Once the pillar is made rigid in the ground, it is not easily removed. This can be overcome by several methods, for example:

(a) A spacing between pillars could be used that will be satisfactory for all uses.

(b) A low-cost pillar could be used which could be abandoned or destroyed.

(c) A pillar could be constructed which can be taken apart in several pieces and removed from the ground.

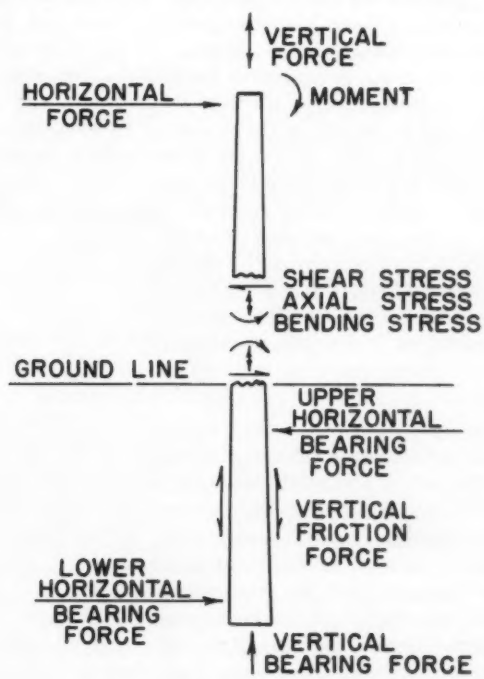


Fig. 2 Structural analysis of a rigid pillar

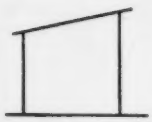


Fig. 3 *(Left)* Shed roof • Fig. 4 *(Right)* Gable roof, ridge support

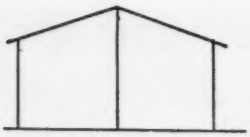


Fig. 5 *(Left)* Gable roof, cantilever ridge • Fig. 6 *(Right)* Gable roof, ridge support

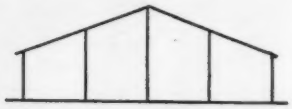


Fig. 7 *(Left)* Combination roof, ridge support • Fig. 8 *(Right)* Combination roof, ridge support

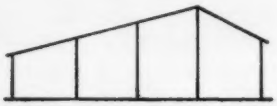
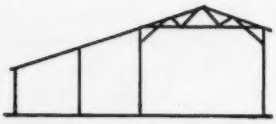


Fig. 9 *(Left)* Gable roof, low trussed ridge • Fig. 10 *(Right)* Combination roof, high trussed ridge, side lean-to



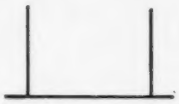
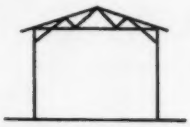


Fig. 11 *(Left) Rigid-pillar walls* • Fig. 12 *(Right)* Gable roof, high trussed ridge



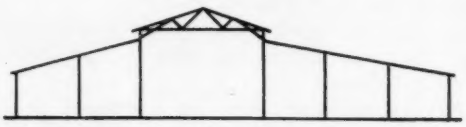


Fig. 13 Monitor roof, high trussed ridge side lean-tos

In the structural analysis of the rigid pillar (Fig. 2) there are three groups of forces to consider which are:

1 *The loading forces.* They are created by the dead, snow, live and wind loads. They can be resolved into a horizontal force, a vertical force and a moment. The moment is created by the vertical forces acting away from the vertical center line and by the transfer of moments from other structural members through non-hinged joints, if any.

2 *The stresses in the pillar.* They can be resolved into axial, shear and bending stresses. If the structure is fastened to the pillar by hinges, the pillar is structurally a cantilever. This would put the greatest combination of stresses at the ground line; therefore, that is where the pillar would need to be the strongest.

3 *The bearing forces of the soil.* They can be resolved into upper and lower horizontal bearing forces, and vertical friction and bearing forces. Because of the wide variation in soil conditions, this group of forces is the most difficult to study. Soil mechanics is involved in this study, and if expertly used it can aid in the design of an economical and adequate rigid pillar. The depth of the pillar in the ground is the most important factor in the rigidity of the pillar. The size of the pillar does not affect the rigidity of the pillar in good bearing soils but does affect the rigidity in poor bearing soils. In the case where the pillar does not have the size or depth to develop the required bearing forces, footings and horizontal bearing developers may need to be added.

There are many materials or combinations of materials which could be used for a rigid pillar. The one that is the most popular and commonly used is the pressure-treated wood pole. However, the other materials that could be satisfactorily used are post-tension concrete or clay block, pretension or reinforced concrete, steel girder or pipe and pressure-treated square wood posts or laminated timbers.

Some materials which could be used for footing and horizontal bearing developers, if needed, are poured concrete, special masonry blocks, treated timbers, well-graded gravel, and metal plates.

Because of the large concentrated vertical design loads, the attachment joint of the roof to the top of the pillar is very important. Many pole-frame buildings have been put up where this joint is the weakest part of the structural design. Because this joint in most cases needs only to be a hinge or pin connection, many designs could be developed which will be satisfactory.

Many different types of roof design can be made for rigid-pillar construction. In some of the present permanent designs, the roofing is applied to either purlins (horizontal longitudinals) or rafters (slanting laterals). The purlins are supported by large rafters which are attached to the pillars, or the purlins are supported by a combination of part of the rafters attached to the pillars and the remaining rafters supported by larger purlins which are also attached to

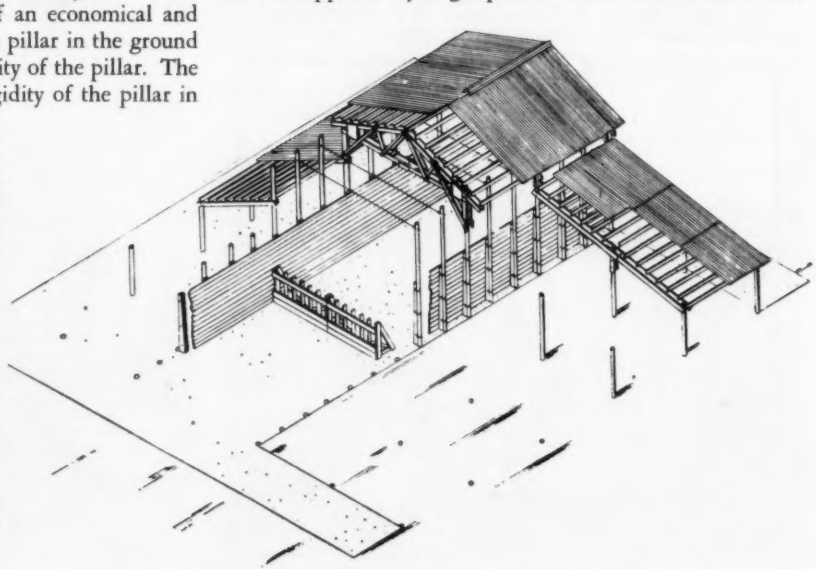


Fig. 14 A rigid-pillar frame design for a multiuse barn

the pillars. The rafters are supported by larger purlins which are attached to the pillars, or the rafters are supported by a combination of part of the purlins attached to the pillars and the remaining purlins supported by large rafters which are also attached to the pillars.

The roof design, in which the order of support is roofing to purlin to rafter to rigid pillar, offers several advantages which are as follows:

1 This design is desirable for wide, clear, lateral spans because the rafters can be trussed.

2 Many cross-sectional shapes can be made (Figs. 3 through 13).

3 This roof design permits top bracing in the lateral direction if needed. Usually the wind forces cause more moment per rigid pillar in the lateral direction than in the longitudinal direction; therefore, if any top bracing is needed, it will usually be in the lateral direction.

4 Some of the combinations can be built by installments.

5 Standard rafters, trussed rafters, attachments to pillar, purlins, pillar spacings, rigid pillars, roofing and walls can be designed for economical mass erection, installment building, changing the size and shape of the building, and for prefabrication.

Plank and beam roof construction works very well with rigid-pillar construction. The planks are fastened to the beams which are attached to the pillars. To obtain wider spacing between pillars, the intermediate beams can be supported by girders attached to the pillars.

Other roof designs which use the advantages of rigid-pillar construction to obtain more flexibility and ease of erection can be made. They are as follows:

1 A design where all the connections of the frame members and roofing application would be of the types of pin connections which are easy to assemble and take apart.

2 A design where the roof is made into prefabricated sections which are lifted into place and assembled.

3 A design where the roof is assembled on the ground and lifted as a whole unit or in sections into place. This design could also permit raising the roof to a greater height, a lower height, or to the ground at a later time.

To gain greater flexibility, the wall can be designed so that it can be made into panels which can be easily attached or detached by pin connections to the pillar. For the more permanent type of wall construction, horizontal girts are attached to the pillars and vertical siding is attached to the girts. The bottom of the walls may have to be a different type of construction and material to meet the greater requirements.

The floor can be of dirt, gravel, asphalt or concrete slab. If concrete is placed directly around the pillar, it can be considered as the upper bearing area and will greatly add to the stiffness of the pillar. However, unless means are made to remove a small section of the slab from around the pillar, a solid-type pillar is difficult to be removed or replaced.

Several types of cornices are used, as follows:

1 Open type for constant ventilation

2 Closed type for no ventilation

3 Adjustable type to control amount of ventilation desired. This latter type should be the most desirable and can easily be incorporated into a design.

A building made of rigid-pillar construction can be designed for easy erection by the farmer or for mass erection by a building erector with special tools and equipment. The erection will usually be in the following order: After the site is chosen, the location of each pillar will be staked out. Holes will be dug at each pillar. For this job a larger post-hole digger will be of great aid. The holes are then cleaned and the footing put in. The pillars are next erected with the method depending on whether the pillar is completely assembled before erection or during the erection. The assembled pillars are put into the holes, located in place, plumbed and partially packed to be held in place but still capable of being moved slightly. Then when enough of the main roof members are put in, to properly space the tops of the pillars and square the building, the pillars are firmly packed. Pillars which are assembled during the erection should be plumbed and packed as they are assembled. Next, the roof is erected, followed by the walls. The walls could be put up before the roof but because they are not needed for the roof support, they are put on after the roof to make it easier for the roof erection. A tractor crane and a traveling scaffold would be good equipment for the pillar, roof and wall erection. The floor slab, if any, can be placed any time after the pillars are plumbed and packed.

Semi-Self-Propelled Harvesting Machine

(Continued from page 238)

The auxiliary engine is a complete, self-contained power unit and can be transported anywhere. It utilizes the Ferguson tractor engine with the advantages to the owner of complete interchangeability of parts between tractor and power unit.

In conclusion, the authors believe that they have been able to accomplish their original objective of developing harvesting machines having the operating advantages of self-propelled machines but at a much lower cost to the farmer. The semi-self-propelled concept has achieved these operating advantages in the following manner:

1 By attaching the units to the side of the tractor, good visibility has been maintained without the fatigue of constantly looking back. All controls have been kept within easy reach of the operator, so that he has complete control of the unit at all times.

2 The articulated coupling of tractor and machine has resulted in a compact, highly maneuverable combination.

3 The use of the outboard-wheel drive unit has eliminated all side draft and made the unit as truly maneuverable as the tractor itself.

4 The means of hitching and unhitching has been made simple and rapid.

5 The auxiliary power unit (when needed) has been made quickly and easily transferable from one unit to another by one man and without any straining or lifting.

6 Last, but by no means least, these machines can be produced at a reasonable cost. Each individual unit will cost no more than the conventional pull-behind machine; however, because of the components which are common to all machines—specially the front quick latch, rear hook hitch, outboard-wheel drive, and power unit—the real advantage is enjoyed by the farmer who owns more than one machine.

Determining Motoring Horsepower

C. W. Terry
Member ASAE

MEN teaching college courses in farm power frequently wish they had an electric dynamometer to determine the motoring torque of their engines. This would allow the students to get a better idea of engine efficiency and indicated horsepower. Where the laboratory facilities include an absorption dynamometer, a reasonably accurate determination of motoring torque may be made as follows: (It is assumed that the engine to be used has an even number of cylinders and a disconnect clutch. In addition, porcelain base knife switches should be provided for shorting the spark plugs.) Warm up the engine to equilibrium temperature in the usual manner. Disconnect the engine from the dynamometer with the clutch and short the plugs of half the cylinders, shorting those that will leave an even firing order. Adjust the throttle to give a desired speed. Engage the clutch, open the shorting switches and adjust the dynamometer to give the same engine speed. Repeat the process, shorting out the other half of the cylinders. Make determinations for as many speeds as desired.

In each case dynamometer torque is that produced by half the engine. Therefore, it may be assumed that the average, from the two halves of the engine, is equal to the motoring torque of the engine.

IHP (of one-half the cylinders)
=BHP (of one-half the cylinders)
=Motoring horsepower of the engine

and

Mechanical Efficiency (all cylinders firing)
=BHP/IHP
=BHP/BHP+Motoring HP
=50 percent

This method is subject to the usual errors due to variation in temperature as soon as the plugs are shorted. Also it must be remembered that pump work, which varies with throttle opening, is included in the motoring horsepower.

A more complete study of motoring horsepower may be made by shorting one cylinder at a time while operating the engine on the dynamometer (see "Internal Combustion Engines" by Lester C. Lichty—McGraw-Hill).

Below are comments on the above method from men in the farm power and engine testing fields:

"Our engine test laboratory compared friction horsepower arrived at by Professor Terry's method of testing with the figures obtained by "motoring" the engine using conventional means. From the results of our laboratory's comparative tests, using our WD-45 tractor engine, it is obvious that there is too great a discrepancy to warrant the adoption of the Terry method without further test data.

Our test engineers comment that the engine is not run under wide-open throttle when using the Terry method which may account for some differences in results obtained. They also comment that a four-cylinder engine with a light flywheel is somewhat 'rough' running when operating on half its cylinders."—C. E. FRUDDEN, Allis-Chalmers Mfg. Co.

"The proposed method for determining friction horsepower of a multiple-cylinder engine proposed by Professor Terry has been read with interest. It appeals to me as having merit in those instances where engine motoring equipment is not available and where approximate results would suffice. Experienced engineers emphasize the difficulty of getting good friction-horsepower data with the best equipment. This difficulty is due to the rapid change in temperature from that when operating to that when being motored. This difficulty would be increased due to unburned fuel in the non-operating cylinders when following Mr. Terry's method.

"A caution should be given that a confined exhaust system, under conditions of Mr. Terry's test, soon becomes charged with unburned fumes and thus may explode.

The idea has merit; shows some careful thinking, and with precautions could be useful."—C. W. SMITH, University of Nebraska

"Unfortunately there is no accepted procedure for determining the operating friction of an internal-combustion engine. All the methods used are subject to a number of variables which are very difficult to maintain and duplicate at any later time. The method proposed by Professor Terry is subject to a number of discrepancies which have not been accurately evaluated; however, it is probably as accurate as any method I know of, and can probably be handled so as to yield consistent results. It is probably the easiest method available for determining the frictional horsepower of an engine and its publication in AGRICULTURAL ENGINEERING would undoubtedly be helpful to engineers engaged in testing procedures; however, it does not offer a practice applying to diesel engines, although suitable equipment could probably be worked out to include this application as well."—W. H. WORTHINGTON, John Deere Waterloo Tractor Works.

"I see no real flaws in the proposed method of finding the friction horsepower while using an absorption brake. The accuracy is somewhat less than when using individual cylinders, but the convenience is definitely greater. The requirement of a disconnect clutch is a definite drawback, and I feel that students should be shown that there is a method available which does not require the disconnect clutch."—Prof. L. L. OTTO, Michigan State College.

The author—C. W. TERRY—is professor of agricultural engineering, Cornell University.

Agricultural Processing Engineering

THE area of agricultural processing engineering seems to be developing into a specific technical field which can be differentiated from the four presently recognized agricultural-engineering fields on the basis of the boundaries of the area, the problems, the work objectives, and training required. Contributions to agriculture comparable to those by agricultural engineers in the divisions of structures, power and machinery, rural electrification, and soil and water will result, if agricultural processing engineering is kept in mind as a specific area of work when studying agricultural engineering problems.

Pumping Plants for Land Drainage

John G. Sutton
Member ASAE

DRAINAGE pumping plants are used in situations where it is neither possible nor economical to obtain outlets by means of gravity drainage ditches. In the Southeast there are considerable areas, especially along the coasts, and some rivers which are flat and relatively low in elevation. Drainage pumping may make possible the future reclamation for agricultural uses of many of these marshes and tidelands.

Pump drainage as discussed in this paper is confined to drainage by pumping primarily for drainage of agricultural land. However, many pumping plants installed for pumping sewage or storm runoff from urban areas are similar in design to pumping plants for agricultural lands.

The largest and most significant current development of drainage pumps in the Southeast are those installed by the U.S. Army Corps of Engineers in the Florida Everglades. These are among the largest pumps in the world. In addition to these large pumps in the Everglades areas, there were 99 drainage enterprises using pumps in Florida reported in the 1950 census. These enterprises operated 354 pumping units and served 293,124 acres. Louisiana is the only other southern state with a large number of drainage pumps. The 1950 census reported 102 pumping units operating in 30 enterprises. The area served by pumps was 179,266 acres. Large drainage pumping plants drain the New Orleans and other southern metropolitan areas.

There are also a considerable number of small farm-drainage pumping plants in the Southeast. No estimate is available as to the number and total acreage drained, but technicians of the Soil Conservation Service have examined and provided technical assistance on many farms having plants which drain from less than 100 up to several hundred acres. Many of them are light propeller-type pumps manufactured by local machine shops. Others are substantially constructed pumps made by leading manufacturers. Most of these farm-pumping plants are located near the coast from North Carolina southward. The typical pumping installation in the Southeast includes a dike surrounding the area to be pumped, an open ditch system to drain the water from the fields to the pumping plant, and a pumping plant to lift the water from the drainage ditch into the outlet.

The reclamation for agricultural production of considerable areas of marshes and tidelands along the coasts of the United States, particularly in the Southeast, is possible by means of drainage pumping plants, a development that has already made substantial progress

Design of Pumping Plants

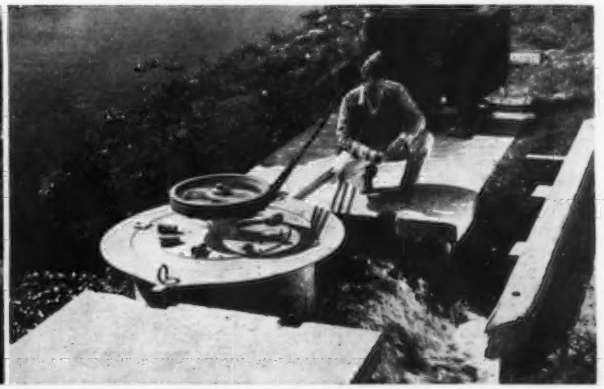
The general quality and type of a pumping installation will depend upon the size and importance of the installation. Where a pumping plant drains a considerable number of farms and the farmers are entirely dependent upon the regular operation of the pumping plant it is of course desirable to utilize the best and most dependable plant and equipment available. More than one pumping unit should be used in such installation so that the land will have some drainage when one unit is being repaired.

Farm installations have been characterized by efforts to save on initial costs of the plant and building. Economy on first cost of many of these plants has been by use of pumps manufactured by local machine shops. Frequently farm tractors or old automobile engines have been used to drive such pumps. Most farm installations have submerged pumps and an open discharge pipe which eliminates need for vacuum pumps, which would be required if it were necessary to prime the pumps.

Inexpensive structures have been used to house many farm pumps. Such installations are subject to fire hazards.

Paper presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Louisville, Ky., February, 1955.

The author—JOHN G. SUTTON—is drainage engineer, engineering division, Soil Conservation Service, U.S. Department of Agriculture.



(Left) A mobile drainage pumping unit on Monreve Ranch, Martin Soil Conservation District, Florida. Unit consists of a 10-in pump, which has a capacity of 2500 gpm, and an 8-hp gasoline engine. (Note that operator is standing on rubber tire on wheel of truck used for transport) • *(Right)* Reversible pump used for drainage and irrigation usually called "water control" in Florida Everglades. The outside cylinder of the pump may be rotated so the direction of flow through pump can be reversed

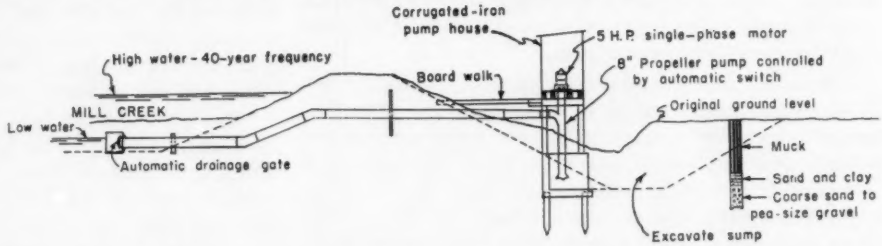
Many farmers are not entirely dependent upon the pumping plants for their livelihood and can well afford to take the chances on breakdown and interruption of services incident to using a low-cost pumping plant.

The following comments on design are more particularly applicable to small farm-size pumping plants. The design and operation of drainage pumping plants is discussed in Technical Bulletin No. 1008, prepared by the author and published by the U.S. Department of Agriculture, May, 1950. This bulletin covers in detail the considerations recommended for design of large and medium-size drainage pumping plants.

Determination of Runoff to be Pumped

The runoff to be pumped often includes, in addition to the normal flow from drains, a large amount of seepage from nearby hill lands and from bordering rivers or creeks.

The rate of surface runoff depends on the amount, intensity, and distribution of rainfall and other precipitation, storage, the size and shape of watershed, the ground slopes, the vegetal cover, and the character of soil. The rate of seepage from hill lands is often an important factor in pumping requirements and its amount depends upon the local conditions. The rate of seepage from adjacent bodies of water depends especially upon the difference in elevation of the water inside and outside the drainage district, the extent of water-bearing gravel and sand under the district, and the length and location of drains touching the water-bearing strata. Because of the large number of influencing factors, the amounts and rates of runoff to be pumped can best be estimated from comparisons with similar areas from which the drainage runoff pumped has been measured.



Elevation of a typical electric-power farm installation of a pumping drainage plant, consisting of a 5-hp motor direct connected to an 8-in vertical pump. (Prepared by Soil Conservation Service, USDA)

For the design of a drainage pumping plant careful estimates should be made of (1) the average yearly runoff, (2) the seasonal distribution of that runoff, and (3) the maximum daily runoff.

The yearly runoff must be known in order to estimate the annual cost of pumping and determine the feasibility of the project. The seasonal distribution of the runoff as well as the lifts must be known in order to design an efficient pumping plant. The maximum daily runoff determines the total capacity of the plant and is considered one of the most important determinations to be made in designing any pumping plant. This determination should be made locally based on conditions encountered.

Maximum Plant Capacity

When the runoff from rainfall exceeds the capacity of the pumping plant, the excess runoff goes into storage. This storage includes (1) ground storage resulting from a rise in the ground-water table, (2) ditch storage, and (3) surface storage in sloughs and low areas. Storage may occur at locations away from the pumping plant and not be reflected in a large or rapid rise of the suction bay. Evaporation and transpiration losses of water help to dry up a drainage district, especially during the growing season.

Crop losses result when the pumping plant capacity is inadequate because of flooding of low areas or of a high ground-water table. It is economical to provide a large pumping capacity to protect land or crops of high value.

The pumping capacity includes runoff from gravity plus seepage which occurs in pumping districts minus storage. These relationships may be expressed as follows: Maximum plant capacity = gravity drainage runoff + seepage runoff — storage.

The required plant capacities in Florida were studied by B. S. Clayton, drainage engineer, Soil Conservation Service, who conducted long-time investigations in the Florida Everglades. He found that many of the northern Everglades pumping districts serve from 5 to 13 sections of land. Most of these pumping plants were designed to remove 1-in runoff per 24 hr. Much of this land is used to grow sugar cane. Experience over a 20-year period indicates that the 1-in rate is generally ample for growing sugar cane on the organic soil of the area.

It was found, however, that truck crops suffered losses where the capacity was only 1 in per 24 hr. As a result of Clayton's investigations the following rates are recommended for land used for growing truck crops in organic soils; 3.0 in for 1 section of land or less, 2.0 in per 24 hr for 2 to 3 sections of land, 1.4 in for 4 to 9 sections of land, and 1.0 in for 10 to 16 sections of land.

In recent years a considerable number of pumping plants have been installed to serve land used for growing pasture grass for cattle. These pumping plants usually drain from 2 to 4 sections of land. A runoff of from 1 to 2 in was commonly provided for these grazing areas and appeared to be adequate.

For mineral soils in the Southeast, E. A. Schlaudt, Soil Conservation Service, Spartanburg, S. C., recommends for areas less than 1 sq mi: 2 in per 24 hr from watershed for improved pasture, 3 in per 24 hr for general crops, and 4 in per 24 hr for truck crops. These coefficients should be increased for high-value truck, fruit, and other crops.

In northern states the required capacities are much less. For general crops a coefficient of 1 to 1½ in per 24 hr is usually used in Ohio and Illinois for farm-size plants.

Kinds of Pumps

The axial-flow or propeller pump is the most efficient type for the low lifts less than 10 ft usually found in the Southeast. This pump has several blades shaped like a ship propeller and is sometimes called a "screw" pump. Some pumps of this type are constructed so that the water may be reversed in direction and the pump used for both drainage and irrigation. It is important that some provision be made

for reversal of flow to obtain water control, especially for organic soils.

Some low-cost propeller-type pumps have been manufactured by local machine shops, using a propeller similar to a boat propeller inside a welded steel pipe used for a casing. The design and efficiency of the so-called "homemade" pump varies greatly. Many of these pumps have been installed for drainage of fields less than 200 acres. The principal advantage of this kind of installation is the low initial cost. A pump to drain the average-size farm can be obtained for several hundred dollars. Such a pump can be operated by a tractor, stationary engine, or an electric motor.

The buildings and foundation are usally simple and inexpensive since large volumes of water at high velocities are not handled. Small farm-size pumping plants are no more difficult to operate than farm equipment. The annual cost of such pumping, including interest and depreciation is usually less than $5 per acre per year. Such installations are subject to failure from different causes; for example, blocks of wood may puncture light casing or a poorly constructed foundation may fail. However, we need to recognize that the low cost of such units justifies considerable risk on the part of the farmer. In many instances he could not purchase a well-designed pumping unit.

The mixed-flow pump combines the centrifugal and propeller principles and is often recommended for operation at heads around 15 ft.

The centrifugal pump itself is not common in the Southeast. It is best adapted to lifts above 15 ft. Such high lifts are unusual in the Southeast.

Most of the farm pumping plants have submerged propellers. The chief advantage of this type of installation is that no priming equipment is necessary. This is an important factor in small plants. It decreases the initial cost and makes for ease of operation. A submerged pump, however, is difficult to clean. Usually, it is desirable to provide hoisting equipment to lift the pump above water to clean trash from the impeller. Well-designed and ample screens are desirable to prevent trash from getting into the pump.

Speed Adjustment

Speed adjustment of drainage pumps is particularly desirable for the plants which handle a lot of water during a year. Pumps are basically designed to operate against a certain lift at design speed. They need to be slowed down to obtain maximum efficiency at lower lifts. Speed adjustment is ordinarily easy to obtain in both gasoline and diesel engines. Where electric motors are used, it is more difficult to adjust the speeds. This can be accomplished by changing the size of pulleys for belt-connected units. Some of the large pumps have two synchronous motors set on the same shaft which operate at different speeds.

Number of Pumps

In large drainage plants two or more pumps are desirable to provide protection in case of breakdown of one unit. Experience in such plants indicates that needed flexibility is obtained by having three units of the same size, or having two units, one with twice the capacity of the other.

Size of Pump

For preliminary computation the size of pump is usually computed on the basis that the water will discharge at the rate of 7 to 9 fps through the pump. This velocity is computed at the pump discharge. The required discharge is based on the total watershed area and the selected runoff coefficient expressed in depth per 24 hr. A convenient unit to use in making this computation is the ratio that 1-in runoff per 24 hrs is equal to 18.857 gpm per acre, or 26.889 cfs per sq mi.

Static Lift and Total Head

In planning pumping plants and in estimating costs, it is important to make engineering surveys for estimating the maximum, minimum, and average static lifts. The pump manufacturer will need these data in order to supply efficient equipment. The static lifts will control the selection of the type of pump.

The range in lifts is required in determining the size of the motor or engine. The maximum horsepower required to drive a pump varies according to the pumping lift. For the centrifugal pump, the horsepower is generally at a peak at a low lift and falls off at higher lifts. On the other hand, for a propeller pump, the brake horsepower required increases as the lift increases.

Characteristic curves are the usual means of showing pump performance. Such curves generally show (1) discharge expressed in gallons per minute (gpm) plotted against total head (feet), (2) brake horsepower (bhp) plotted against discharge, and (3) pump efficiency (percent) plotted against discharge. The three curves need to be shown for each speed if the pump operates at more than one speed.

Usually drainage pumps may be furnished with the maximum efficiency something over 80 percent. A well-designed pump should have an efficiency above 70 percent over a wide range of operating lifts. Important pump installations are usually supplied by a manufacturer based on specifications prepared by the purchaser. The purchaser specifies the requirements at maximum and other operating lifts. Generally the manufacturer supplies a set of characteristic curves to the purchaser. Most manufacturers base such curves on factory tests of the pump furnished or on the tests of a geometrically similar pump.

Pump Efficiency

Pump efficiency is computed by the following formula:

$$e=\frac{gpm\times H_t}{bhp\times 3960\times e_t}$$

where

e = pump efficiency

gpm = gallons per minute

H_t = total head on pump (feet)

bhp = brake horsepower (output of motor or engine)

e_t = transmission efficiency of belt or gear connecting engine or motor and pump (ratio, i.e., 97 percent = 0.97).

For units where the pump is directly connected to motor or engine e_t is 100 percent, and bhp is equal to the horsepower input into pump shaft. For belt-connected units e_t ranges from 95 to 98 percent since only a small loss of power results.

Discharge and Suction Pipes

Discharge pipes should go over the levee near the high water level in most drainage-pumping installations. If the pump is not submerged, the end of the discharge pipe should be below the low-water stage of the discharge bay so that the pump may be primed easily. This arrangement of the discharge pipe permits a siphon action in the discharge pipe which reduces the total head on the pump and the power used for pumping. Where the discharge pipe is submerged, an automatic flap gate should be installed on the end of the pipe to prevent backflow through the pump when it stops.

An alternate arrangement is for the discharge pipe to discharge above high water in the discharge bay. This arrangement, although less efficient, is ordinarily used in small plants in combination with a submerged pump. This eliminates the back-flow through the pump and is the safest and most practical arrangement for automatic operation.

The friction losses in the suction and discharge pipes may be reduced by designing the pipes to expand from the connections at the pump. This is of more importance in the large plants. A rounded entrance for the suction pipe is recommended. The expansion of the suction pipe permits the suction bay to be pumped low without the pump losing its prime.

Location of Pumping Plant

The location of the pumping plant is determined largely by the topography of the area and the location of the outlet stream or body of water in which the pump is to discharge. Some areas may have alternate locations and selection may be based on the advantages with respect to foundation conditions, construction of drainage ditches, proximity of roads, living quarters, and power lines for electric plants.

Foundation conditions should be determined by means of soil borings. The site should have stable foundation material. A good foundation is a safety factor during flood conditions. Some pumping plants have been destroyed by levee breaks at the pumping plants due to quicksand or other unstable material at or near the plants.

Buildings and Suction Bay

The buildings used to house drainage pumping units vary greatly, depending upon the type of installation, size, type of power, soils and foundation conditions, and desires of the owners. Many drainage districts have attractive masonry and steel fireproof buildings resting on piling. In contrast, some pumping units are set on skids on the ditch bank with little or no housing. Because of the volume of water passing through at high velocity, a substantial foundation and well-designed suction bay are mandatory to prevent undermining of large drainage pumping plants.

As the size of the plant decreases there is a greater choice permissible in type of construction and foundation since erosive forces are less. A small substantial fire-resistant building is a good investment even for farm pumping plants. Electrical and accessory equipment need to be protected. A building may also prevent damage to equipment by children or trespassers.

The suction bay is often used as the foundation for the pump or the pump and motor. This arrangement frequently consists of a rectangular pit enclosed on three sides by concrete walls. The pump may rest on a steel beam with a vertical suction pipe extending down in the suction bay the necessary distance below water. This arrangement is satisfactory for vertical-type submerged pumps as well as for pumps set above water which require priming. Electric motors may be set on a pump on the beams spanning the bay. Diesel engines should rest on a substantial foundation which adjoins the suction bay. Another arrangement is to set the pump to the side of the suction bay with the suction pipe entering the pump horizontally and curving downward into the suction bay. One or two sets of screens should protect the suction bay from trash. The screens should have ample opening at low water to keep the velocity through the screen down to around 2fps. Screens should be planned so they are easy to clean.

The pump or suction pipe should be submerged an adequate depth in order for the pump to operate efficiently. In the preliminary plans, a submergence of 3 ft below normal low-water pumping level may be assumed for sea-level pumping. For 1,000 ft above sea level, the minimum submergence should be increased to 4 ft. These figures should be modified on specific advice from the pump manufacturer based on requirements of the pump selected.

The minimum clearance between the pump and sidewalls or suction pipe and sidewalls may be computed as 1.5 x pump size. For example, a 10-in pump requires a minimum 15-in clearance from the sidewalls. The minimum clearance between the suction edge of the intake pipe and the floor of the suction bay may be designed equal to the pump size. For example, a 10-in pump requires a 10-in clearance between the bottom of the suction pipe and the floor of the suction bay. These dimensions should be modified on the advice of manufacturers.

Storage at Suction Bay

Water storage at the suction bay is advantageous for several reasons. The suction bay should be controlled within small limits to provide a more constant operating condition. If the storage available at the suction bay is small, the pumping plant will draw the water down rapidily under ordinary conditions and pumps will take air and operate less efficiently. The pumping lift would be increased and frequent starting and stopping of the pumps will be required. A large storage at the suction bay will frequently make it possible to eliminate night operations and may result in decreased labor costs.

Where large areas are drained by pumping, it is frequently desirable to leave some sloughs and depressional areas undrained for storage. Usually it is desirable to excavate the main ditch leading to the pumping plant deeper and wider than necessary to provide storage.

Automatic Operation

Automatic operation of drainage pumping plants is feasible if electric power is used. This is particularly desirable in operation of small plants to save operating expenses and to provide constant control of drainage water. Automatic control may be obtained by a float which starts the motor when the water in the suction bay rises to a predetermined elevation. The pump then starts and gradually lowers the water and float. The water is pumped down to a level so the float trips a switch and cuts off the motor. Another device is to use an upper and lower electrode which will activate switches which start and stop the pump.

Analysis of Air Flow in Grain Drying

Carl W. Hall
Member ASAE

A method for rapidly and accurately determining air-flow values in grain-drying structures of non-rectangular cross section

THE analysis of air-flow data collected in a structure of non-rectangular cross section during grain drying, by existing methods, requires considerable time. There is great need for a quick, accurate method of making such determinations. The method presented in this paper was developed to meet these requirements.

The commonly accepted measure of the rate of air flow is cubic feet per minute per bushel of grain. The air-flow rate may be expressed as an average for the entire bin, but would not serve to determine the air-flow rate at different locations in the bin. The air flow per accumulated bushel of grain (cfm/acc bu) also seems to be appropriate. Thus at the location of the entrance of air to the grain, the air-flow rate approaches infinity and decreases as the air moves through the grain. It is necessary to obtain a relationship between static-pressure lines and air flow in cubic feet per minute per bushel.

The static pressure is measured at the intersections of a grid system perpendicular to the air tunnel of the bin. These pressures are plotted at their appropriate positions on a cross-section sheet of the building. Lines connecting points of equal static pressure (isopressure lines) are drawn, normally for 0.1-in intervals. The next step is to obtain the air-flow rate in cubic feet per minute per square foot of cross sectional area perpendicular to the air flow. An air-flow chart was prepared for *wheat* in which the air flow in cubic feet per minute per square foot is plotted against the depth in inches and is represented by a straight line on logarithmic paper, for various static pressures (Fig. 1). The data are represented in this form so that the relationships for depths less than 12 in are obtained easily and accurately.

Paper prepared expressly for AGRICULTURAL ENGINEERING. Approved for publication as Journal Article 1709 by the Michigan Agricultural Experiment Station, East Lansing.

The author—CARL W. HALL—is associate professor of agricultural engineering, Michigan State College.

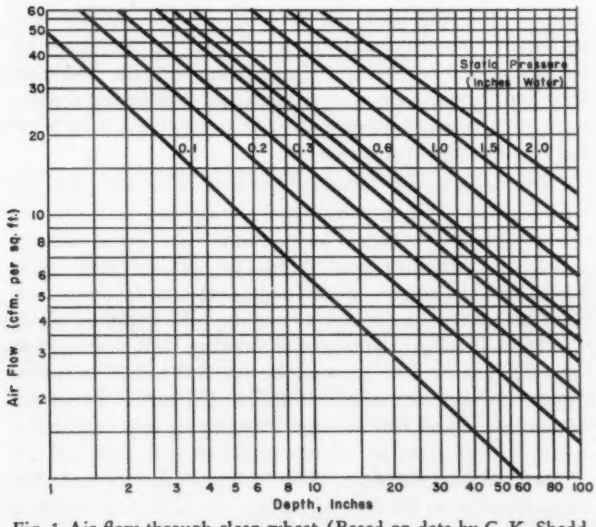


Fig. 1 Air flow through clean wheat (Based on data by C. K. Shedd, "Resistance of Grains and Seeds to Air Flow," AGRICULTURAL ENGINEERING, vol. 34, September, 1953)

Procedure of Analysis

1 Draw isopressure lines at 0.1-in intervals.

2 Use the coordinates, X, Y, Z, as designated, in inches.

3 Measure X, the distance in inches between isopressure lines (Fig. 2).

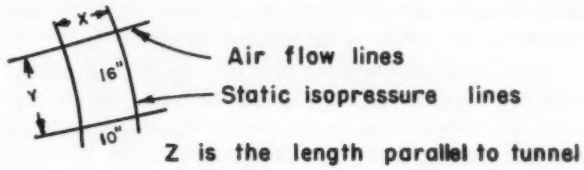


Fig. 2 Dimensions of a section of grain

4 Read air flow for X value from air-flow chart (Fig. 1) for grain in bin.

5 Derive equation for air flow per unit volume of grain which can be used for all similar problems.

(a) Average cross-sectional area (square feet) perpendicular to flow of air, represented in the YZ plane with values in inches, is $(\text{Avg } Y)\ (Z)/144$

(b) Volume (cubic feet) of section of grain is $(X)\,(\text{Avg } Y)\,(Z)/1728$

(c) Air flow per unit volume of grain, cfm/cu ft = (cfm/sq ft) (average cross-sectional area) / (volume of section)

Substituting

$$\text{cfm/cu ft} = \frac{(\text{cfm/sq ft})\,[(\text{Avg } Y)\,(Z)/144]}{(X)\,(\text{Avg } Y)\,(Z)/1728}$$

$$= 12(\text{cfm/sq ft})\,(1/X) \quad . \quad . \quad . \quad [1]$$

(Multiply equation [1] by 1.25 to get cfm per bushel.)

$$\text{cfm/bu} = 15(\text{cfm/sq ft})\,(1/X^*) \quad . \quad . \quad . \quad . \quad [2]$$

6 Substitute values in equation [2]. Note that only the distance X between isopressure lines, drawn for each 0.1 in of pressure is required *(a)* to obtain air flow from Fig. 1 and *(b)* to represent directly the value of X in inches. Thus, for wheat in the example, $X = 10$ in, representing 5.7 cfm/sq ft, Fig. 1,

$$\text{cfm/bu} = 15(5.7)\,(1/10) = 8.6$$

It will be noted that the distance between air-flow lines in Fig. 2 was not used, which therefore indicates the air-flow lines are unnecessary.

7 Determine the air flow per accumulated bushel of grain as follows:

(Continued on page 250)

Drainage Recommendations by Soil Types

Keith H. Beauchamp and Guy B. Fasken
Member ASAE

THE relatively recent tile drainage recommendations which relate the tile depth and spacing to soil types has gained in popularity among those who plan farm drainage systems. They are more specific and easier to apply than any previous information concerning tile depths and spacings. Such recommendations have been set up on a state basis by Ohio, Michigan, Illinois, Iowa, Indiana, and Minnesota.

Determination of the most effective depth and spacing of tile in the many different types of soils has long been a perplexing problem. This is because the rate at which water moves through a soil is governed largely by the texture and structure of the soil. Information about the movement of water through different kinds of soil, therefore, is essential for the correct design of tile drainage systems.

The effects of tile depth and spacing on crop productions has been recognized since the beginning of drainage with tile. Opinions as to the correct depths and spacings differed greatly. Experience usually dictated the tile specifications for each locality. To get people to deviate from the dictates of local practice as to tile depth and spacing is difficult, and also rather dangerous to an engineer's reputation unless quick and excellent results are obtained from the changes. Even today, with our increased knowledge of soil and the movement of water, the field engineer resorts to recommendations arising from local practice when he lacks definite information as to the most desirable installation for that particular soil.

Local information and practices in tile installation should not be ignored, however, even in the light of the increased knowledge. Examination of the local tile installations will provide valuable information as to future recommendations for many of them are successful. They are something of a laboratory for the use of the engineer.

The American Society of Agricultural Engineers has had a committee working on the recommendations of depth and spacing of tile drains. Research people have been working on this problem for many years and have devised several good methods of determining depth and spacing of tile drains. These methods usually involve a numerical value of soil permeability. However, the methods have not been simplified to the point that they permit widespread use by SCS field technicians. Their job is to design tile systems on a production basis, so they need a type of recommendation that can readily be used without lengthy investigations and minute tests.

The tentative ASAE Recommendation: "Design and Construction of Tile Drains in Humid Areas" published in July, 1953, issue of AGRICULTURAL ENGINEERING, lists Table 1. The table is applicable when a parallel system of tile is used for field crops. The spacing between laterals varies according to soil texture.

Tile depth and spacing recommendations need to be constantly revised in order to reflect new research information and field experience

TABLE 1

Soil	Permeability	Spacing
Clay and Clay Loam	Very slow	30 to 70 ft
Silt Loam and Silty Clay Loam	Slow to moderately slow	60 to 100 ft
Sandy loam	Moderate to rapid	100 to 300 ft
Muck	. . . . .	50 to 200 ft

It will be noted that a wide range of spacing is provided for each soil texture. The suggested depth of the tile is three to four feet in mineral soils and over four feet in organic soils. From these general recommendations, the design engineer is required to determine the depth and spacing of tile to fit a particular soil condition. Unless he has had a wide experience with the soils with which he is working, or is familiar with research studies on them, he necessarily will select a depth and spacing within the above recommendations and in conformity with the general local practice.

In making such a selection, the engineer feels that he has used a great deal of common sense and has used all the practical information available. He would be reluctant, however, to say that he has selected the most suitable depth and spacing. For a long time, engineers have felt a need for closer guide lines based upon all the available soil information as well as group opinion, so that the selection of depth and spacing would not be a one-man decision.

The states mentioned above prepared recommendations for tile depth and spacing by soil groups. The recommendations are based upon the use of good crop rotations and agronomic practices and adequate field surface drainage. Engineers, soil scientists, and agronomists of the Soil Conservation Service, extension services, and experiment stations worked together to prepare the best possible guide by pooling all available information.

The soil scientists separated the soils of the state into soil types and soil groups which had similar soil structure and drainage characteristics. The agronomist and plant material people specified root zone depth, the desired water table depth, and the degree of drainage necessary for maximum plant response. The engineers specified the depth of tile in respect to loading, freezing and thawing, and construction hazards. Taking into account the research available within a state and in other areas of similar soil types, drawdown studies, and local farmer experience, the group prepared a depth and tile-spacing recommendation for each of the various soils of the state. The recommendations included suggestions as to the type of surface drainage best suited to the soil type and in some instances included farming recommendations.

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Minneapolis, Minn., June, 1954, on a program arranged by the Soil and Water Division.

The authors—KEITH H. BEAUCHAMP and GUY B. FASKEN—are, respectively, irrigation engineer and drainage engineer, Soil Conservation Service, U.S. Department of Agriculture.

The recommendations, however, are only a guide. Their use does not eliminate the necessity for the engineer to make further inquiry into soil conditions, since recognition of the soil group is not alone sufficient for the engineer to apply the tile recommendations. There are many variations in each soil group and the engineers will still have to make soil borings and other investigations into local conditions in order to correctly apply the tile recommendations.

Table 2 is a composite of the recommendations of the several states for various soil types. The table is arranged so that the soil types are grouped according to their general textures in order that a ready comparison of the recommendations can be made. Inspection of Table 2 will show that the texture classifications have been broken into finer texture groups than those shown in Table 1. This permits the making of a smaller range in tile-spacing recommendations. Where two depths are listed, the closer spacing applies to the shallower depth. In Ohio, for example, soil group 6389 includes Paulding clay. The recommended depths of tile for this soil group is 3 to 3½ ft and the spacing from 45 to 60 ft for field crops. When special crops, such as truck crops, are to be grown the spacing should vary from 25 to 45 ft. Shallow surface drains should be developed to remove the surface water. Special practices are needed to improve permeability of the soil.

For another example, we see that soil group 84, Clyde silty clay loam — in Iowa should have a tile depth from 3½ to 4 ft, with the spacing varying from 80 to 90 ft for the shallower depth and 90 to 100 ft when the tile is deeper. Surface drainage is required for these soils.

In Illinois, soil group 14 includes Harrison silt loam. The recommended depth of tile for this group is 3½ to 4 ft and the spacing from 80 to 100 ft for the tile laterals to drain field crops. The surface drainage practices usually required for this group of soils are diversions and waterways. Surface drainage found in this soil group is usually adequate without additional channels. Under remarks column is noted that random tile will sometimes be sufficient.

Another example is soil type 84, Maumee sandy loam, in Michigan. The recommended depth is 2½ to 3½ ft with a tile spacing of 82 to 115 ft. Shallow waterways and ditches are required to care for surface drainage. Special investigation on this soil type should be made before selection of tile depth and spacing. Special binding material is recommended.

In Indiana, only surface drainage is recommended for soil 6501, Quinn loamy fine sand. The fertility of the soil is

TABLE 2. TILE DEPTH AND SPACING RECOMMENDATIONS

STATE	SOIL GROUP	DOMINENT SOIL TYPE	DEPTH IN FEET	SPACING GENERAL CROPS	SPACING SPECIAL CROPS	SURFACE DRAINAGE	REMARKS
Ohio	6389	Paulding Clay	3-3½	45-60	25-45	Develop shallow surface drainage	Tile recommended for field crops and special practices. Necessary to improve permeability.
Indiana	238	Brookston Silty Clay	3-3½	50-75	---	Develop shallow surface drainage	Tile recommended for field crops and special practices. Necessary to improve permeability.
Michigan	899	Toledo Silty Clay	3-4	33-49	---	Develop shallow surface drainage	Special blinding will improve system.
Indiana	108	Brookston Si. Cl. Loam	3-3½	65-100	30-65	Shallow waterways, diversions & blind inlets	Tile recommended.
Illinois	28	Ashkum Clay Loam	3-3½	75-90	---	Requires surface drainage	Tile recommended.
Iowa	84	Clyde Si. Cl. Loam	3½	80-90	---	Requires surface drainage	
Iowa	84	Clyde Si. Cl. Loam	4	90-100	---	Requires surface drainage	
Minnesota	114	Glencoe Si. Cl. Loam	3½	70	---	Surface drainage and inlets	Sweetclover rotation 4-6 yrs.
Indiana	442	Homer Silt Loam	3	65-100	---	Shallow waterways & diversions	Except where limestone or sand is within 36".
Illinois	14	Harrison Silt Loam	3½-4	80-100	---	Diversions - waterways	Random systems often applicable.
Iowa	107	Webster Silt Loam	3½	80-90	---	Surface drainage required	
Iowa	107	Webster Silt Loam	4	90-100	---	Surface drainage required	
Michigan	640	Conover Silt Loam	3-4	49-82	---	Diversions and waterways	Tile recommended.
Ohio	602	Crosby Silt Loam	3-3½	50-70	25-50	Drainage type terraces & waterways	Always tile for special crops.
Indiana	289	Maumee Fine Sandy Loam	2½-3	150-200	---	Use open ditches 40-80 rods	Tile not recommended
Ohio	9293	Maumee Sandy Loam	3½-4½	100-120	50-100	Shallow waterways	Can use closer spacing and less depth if scattered through other soils.
Michigan	841	Maumee Sandy Loam	2½-3½	82-115	---	Shallow waterways & ditches	Requires special investigation and special blinding.
Minnesota	120	Berrien Sandy Loam	3	100-120	---	Surface drainage	Provide blinding material, extra care necessary.
Michigan	805	Ogemaw Loamy Sand	---	---	---	Drainage rarely recommended	Shallow hardpan present.
Indiana	6501	Quinn Loamy Fine Sand	---	---	---	Open drains	Tiling not recommended - very low fertility.
Illinois	34	Blueford-Hoyleton Silt Loam	---	---	---	Complete systems - bedding on flats, waterways and drainage on slopes	Tiling not recommended (shallow Clay Pan).
Michigan	W8	Shallow Muck over Mineral Soil except Sand	3½-4½	33-132	33-132	Diversions and open ditches	Control drainage recommended.
Michigan	W7	Shallow Muck over Sand	---	---	---	Open ditches	Water Table control.
Indiana	2	Carlisle Muck Shallow Phase 18"-36" over Clay	3½-4	65-100	30-65	Diversions and interception ditches	Tiling recommended where underlying clay is permeable. If impermeable, clay layer should be at least 36" below surface. Spacing varies with depth of Muck.
Minnesota	84	Shallow Peat 18"-36" over heavy material	3½	50-100	---		Underlying material to be examined to determine spacing.
Minnesota	83	Shallow Peat & Muck underlain at 18"-36" with Sand	---	---	---	Surface drainage.	Tile drainage not recommended unless controlled.
Minnesota	81	Deep Organic Soils Peat and Muck	4-5	50-200	50-200	Diversions and interception ditches.	Peat composition will determine spacing.

very low and the economics of tiling the land is questionable.

We find an example of organic soils in Minnesota soil type 84, shallow peat 18 to 36 in over heavy material. The recommended depth is 3½ ft with tile spacing from 50 to 100 ft. It is recommended that the underlying material be examined in order to make the spacing selection.

A tile depth and spacing recommendation for each soil type within a state provides an excellent working tool for the Soil Conservation Service personnel assisting soil conservation districts, extension service personnel, and other agencies interested in tile drainage.

Although the table is called "Tile Recommendations," it will be noted that it also contains recommendations as to the type of surface drainage required. In many cases, it recommends against tiling. In fact, it is really a drainage recommendation chart. As has been said before, the charts do not eliminate the necessity of further investigations. Instead, the charts contain references to the need for further investigations as to the local soil conditions, surface drainage needs, and economic hazards.

The use of the tile recommendations charts can be illustrated by reference to Fig. 1, a typical soils map of a small area in Indiana. Three types of soils are shown for which Table 2 shows the following recommendations:

TABLE 2

Soil	Depth	Spacing
108 Brookston Silty Clay Loam	3 to 3½ ft	65 to 100 ft
2 Carlisle Muck	3½ to 4 ft	65 to 100 ft
289 Maumee Fine Sandy Loam	2½ to 3 ft	165 to 200 ft

Tiling is recommended for Brookston Silty Clay Loam but not generally recommended for Maumee Fine Sandy Loam. Recommendations for Carlisle Muck Soil are dependent upon local conditions. This situation shows that the recommendation charts actually define the limits on tile depth and spacing in each soil. Furthermore, it indicates the need of investigating the local soil conditions and the local economic experiences on the soils involved before making the final decision on the depth and spacing of the tile.

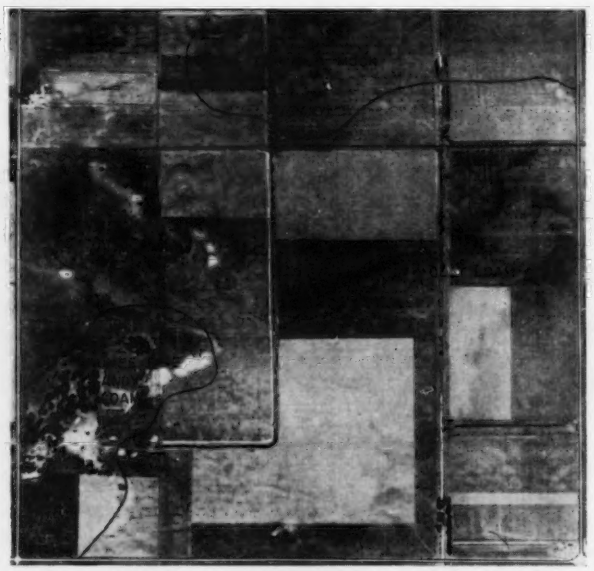


Fig. 1 Typical soils map of a small area in Indiana

The tile recommendation charts are in need of constant revision. They should be reviewed at intervals so that future research information and field experiences may be reflected in the recommendations. Compiling of the recommendations brought out the need for further research concerning permeability, drawdown, maintenance, production, and management.

Analysis of Air Flow

(Continued from page 247)

Let X' (Fig. 3) equal the distance in inches from the point where the air enters the grain and the point where air flow per accumulated bushel is to be found. The value for (cfm/sq ft) is obtained from Fig. 1 at the X' value for depth and static pressure drop from the entrance of the air to X'.

$$\text{cfm/acc bu} = 15(\text{cfm/sq ft})\,(1/X') \quad . \quad . \quad . \quad [3]$$

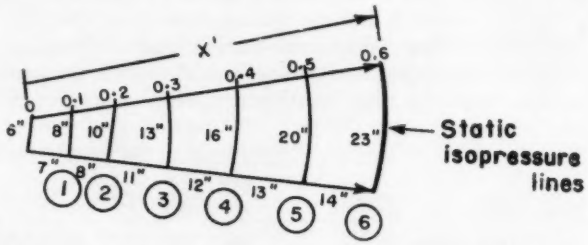


Fig. 3 A section for determining air flow per accumulated bushel

TABLE 1. PROPOSED METHOD OF DETERMINING AIR FLOW
(For section represented in Fig. 3)

Static-pressure-line number	1	2	3	4	5	6
Static pressure drop, inches of water	0.1	0.2	0.3	0.4	0.5	0.6
X, inches of grain between pressure lines	7	8	11	12	13	14
Air flow, cfm per bushel (equation 2)	17.0	13.1	7.1	6.0	5.1	4.5
X', inches of grain accumulated	7	15	26	38	51	65
Cfm per accumulated bushel (equation 3)	17.0	7.4	3.6	2.3	1.6	1.2

TABLE 2. AIR FLOW DETERMINED BY PRESENT METHOD*
(For section represented in Fig. 3)

Static-pressure-line number	1	2	3	4	5	6
Static pressure drop, inches of water	0.1	0.2	0.3	0.4	0.5	0.6
L, inches of grain between pressure lines	7	8	11	12	13	14
Bushels per cfm	0.059	0.076	0.141	0.166	0.197	0.224
Air flow, cfm per bushel	17.0	13.1	7.1	6.0	5.1	4.5
Accumulated bushels per cfm	0.059	0.135	0.276	0.442	0.639	0.863
Air flow, cfm per accumulated bushel	17.0	7.4	3.6	2.3	1.6	1.2

* Hukill, W. V., and C. K. Shedd. Ventilation of oats in 16x20-ft quonset buildings, unpublished USDA report, September 21, 1953.

Summary

The method presented is for rapidly determining the airflow values in grain-drying structures of non-rectangular cross section. Only the distance between static-pressure lines is required, when used in conjunction with a chart presented for wheat.

*The distance X is in inches.

The Globe Thermometer in Agricultural Research

T. E. Bond and C. F. Kelly
Member ASAE Member ASAE

Advantages outweigh limitations and establish the black globe thermometer as a convenient tool in many areas of research

EXCEPT for radiation, all the components of a thermal environment are measurable with common instruments. Yet radiation is a significant portion in the transfer of heat between an animal and its surroundings; a full evaluation of the relationship of animal comfort and production to the environment depends greatly on establishing quantitative values for this factor.

Various indices, such as effective temperature (1)*, operative temperature (2), and sol-air temperature (3)—have been used as single representations of convection and radiation heat exchange between an object and the thermal environment† The katathermometer (4), eupatheoscope (5), thermointegrator (6), sol-air thermometer (7), coolometer (8), and the black globe thermometer (9) are some of the special instruments designed to measure this exchange. Because it provides a practical and inexpensive means of isolating mean radiant temperature from other factors in the thermal environment, the black globe thermometer was preferred for determining the radiation component of the environment in animal studies in which the U.S. Department of Agriculture and the University of California at Davis are cooperating.

The temperature of the black globe thermometer also provides an indication of the combined effects of radiant energy, air temperature, and air velocity, thus giving a measure of comfort level for non-sweating animals. In the laboratory (California Psychrometric Chamber), where swine are being studied under controlled environments to determine their heat and moisture loss, the black globe is used to determine the mean radiant temperature of the laboratory. In field studies it is used to determine the total whole-space irradiation at a given location, such as under a shade.

This paper presents results of a study of the physical characteristics of the black globe thermometer, together with some aspects of its practical application in laboratory and field studies in agricultural research. The described advantages and limitations further an understanding of its possibilities as an experimental tool.

Factors Measured

Various observers have used blackened spheres as indicators of radiant heat. Vernon (10, 11) tried various constructions—pasteboard spheres covered with cloth, blackened glass spheres, and spheres of thin copper painted matte black—with mercury thermometers inserted to their center points, to indicate the globe temperature. Vernon used such globe thermometers to estimate the "effectual radiation temperature" (average excess temperature of the globe surface above that of surrounding air) to which a living body was exposed from various heating and cooling sources in a room. In studying the performance of unit ventilators in the heating and cooling of classrooms, Potter and Baker (12) used a "black body resultant temperature" (which was merely the temperature assumed by the globe when subjected to a given combination of air temperature, radiant energy, and air movement), "since the skin and clothing react to these factors in approximately the same way as a 6-in globe, because of surface area to volume proportions". Bedford and Warner (9) used a globe of that size as an indication of mean radiant temperature, which is perhaps a more generally applicable quantity. Brooks and Kelly (13) suggest the black globe thermometer as part of the minimum instrumentation necessary for reliable interpretation of agricultural environment. The American Society of Heating and Ventilating Engineers (ASHVE) Research Technical Advisory Committee (14) recommends the globe thermometer as the standard field instrument for measurement of mean radiant temperature. Also, globe thermometer readings can be used to calculate the spherical or whole-space radiation on the globe, a quantity which, in this paper, is termed "radiant heat load." These quantities are discussed in subsequent paragraphs.

Mean Radiant Temperature. The mean radiant temperature (MRT) of an environment is the temperature of a uniform black enclosure with which an object would exchange the same amount of energy as in the actual environment. It should be noted that this definition refers the mean radiant temperature to an object. In the case of a mean radiant temperature determination with the globe thermometer, the globe is the object and the MRT so determined will be strictly true only for the globe. For a man, an animal, or some other object, the MRT would be somewhat different, depending on the shape factor of the object with respect to different radiating sources of the surround.

Radiant Heat Load. The radiant heat load (RHL) is the total radiation received by an object from all of the surrounding space. It is the spherical, or whole-space, irradiation of the object. This definition says nothing of the net exchange of radiation between the object and its surrounding envelope, but includes only the incoming radiation at the object.

Determination of MRT and RHL from Globe Data

Bedford and Warner (9) studied the quantitative equilibrium heat-exchange characteristics of a 6-in black globe and

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Acknowledgments: The authors express their appreciation to J. R. Goss and F. A. Brooks, agricultural engineering department, University of California, for their assistance in the preparation of this paper.

*Numbers in parentheses refer to the appended bibliography.

†These indices do not take account of conduction to the ground or other object.

its surroundings and expressed the radiation exchange by the equation:

$$H_r = e\,\sigma(T_s^4 - T_g^4) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [1]$$

and the convection exchange by the equation:

$$H_c = 0.169\,\sqrt{v}\,(t_g - t_a) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

where

t_g = temperature of globe, F

t_a = temperature of air, F

t_s = mean radiant temperature, F

v = air velocity, fpm

e = emissivity of globe surface, 0.95

σ = Stefan-Boltsman constant, 0.173×10^{-8}

$T_g = t_g + 460, \qquad T_s = t_s + 460$

Under steady state conditions, heat gained or lost by radiation to or from the globe must exactly equal that lost or gained by convection, and the radiation and convection heat-exchange equations can be equated and solved to give:

$$t_s = 100\,[(T_g/100)^4 + 1.028\,\sqrt{v}(t_g - t_a)]^{1/4} - 460 \quad [3]$$

If the equivalent uniform temperature of the surround (MRT) is t_s, then the radiation emitted by this surround to the globe is the radiant heat load (RHL) on unit area of the globe in Btu per hr per sq ft as determined by the Stefan-Boltzman formula:

$$\text{RHL} = \sigma T_s^4 = 0.178\,\sqrt{v}(t_g - t_a) + \sigma T_g^4 \quad . \quad . \quad [4]$$

The mean radiant temperature can be found from equation [3] if air temperature, air velocity, and globe temperature are known. The radiant heat load (RHL) can be determined from the mean radiant temperature or calculated directly from equation [4].

With an extensive amount of data, calculations from these equations are time consuming. A chart was developed (Fig. 1) that will speed conversion of the variables—air temperature, globe temperature, and air velocity—to mean radiant temperature. The scope of the chart covers the range of globe thermometer readings that the authors have encountered in both laboratory and field conditions. For specific applications, a chart of more limited range will provide greater accuracy in interpolation. Charts similar to Fig. 1 can be easily constructed by plotting the two sets of curves shown as equations [1] and [2] above, with H_r and H_c as abscissa, and using the same numerical scale for both. For measurements of nocturnal radiation, when globe temperatures will be lower than air temperatures, a chart must include negative values for the temperature difference scale.

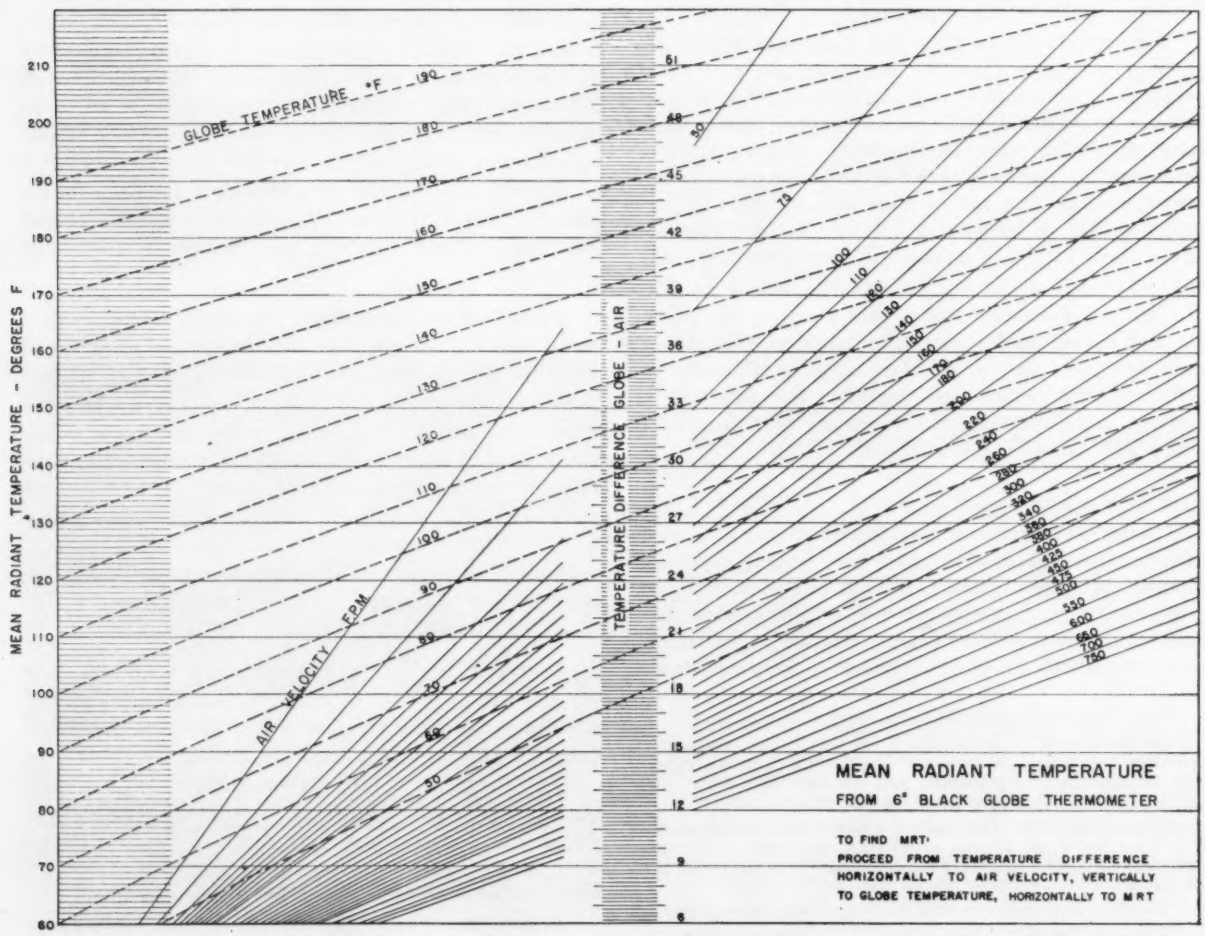
MEAN RADIANT TEMPERATURE - DEGREES F
GLOBE TEMPERATURE °F
AIR VELOCITY FPM
TEMPERATURE DIFFERENCE GLOBE - AIR
MEAN RADIANT TEMPERATURE
FROM 6" BLACK GLOBE THERMOMETER
TO FIND MRT:
PROCEED FROM TEMPERATURE DIFFERENCE HORIZONTALLY TO AIR VELOCITY, VERTICALLY TO GLOBE TEMPERATURE, HORIZONTALLY TO MRT

Fig. 1 Chart for use in converting 6-in black globe thermometer readings to mean radiant temperature of surroundings with respect to the globe

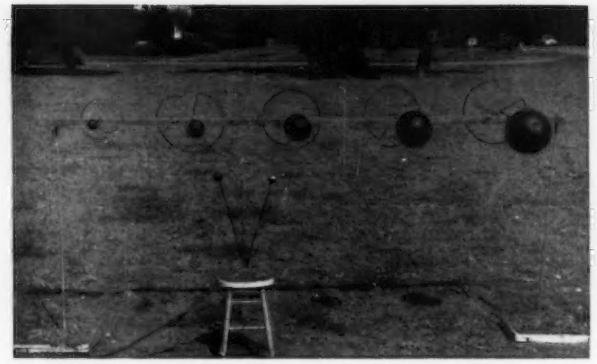

Fig. 2 Spherical radiometer (small black and silver globes at center) in use to check results obtained with 2, 4, 6, 8, and 10-in-diam globe thermometers in sun

Accuracy of Globe Thermometer

The accuracy of the globe thermometer in measuring mean radiant temperature was determined by comparison with the directional radiometer method described by Kelly, Bond, and Ittner (15). With the directional radiometer method, the average temperatures of areas to which the object is exposed are determined with the radiometer, and weighted by their geometrical shape (or angle) factors with respect to the object, to determine the true MRT. A series of observations and calculated MRT's, as given by the globe thermometer and by the directional radiometer, are compared in Table 1.

The values for MRT in Table 1 determined by the two methods agree very well. It takes considerably longer to get a complete set of readings with a directional radiometer than with the globe thermometer, and during this extra time there is a real possibility of change in MRT or air velocity.

The directional radiometer method is tedious to apply, because of the many separate observations and calculations involved. A total spherical radiometer (Fig. 2), was specifically designed for this project by Dunkle and Gier (16) to measure the radiant energy from the surroundings (all of space) to a given unit spherical area. This instrument is calibrated to indicate radiant heat load (RHL of equation [4]), from which the MRT of the surround can be determined. This provided a second method of evaluating the accuracy of the globe theremometer (Fig. 3).

The mean radiant temperature in a room with controlled environment and constant air velocity was determined with a globe thermometer and compared with spherical radiometer readings. The similar results given by the two methods are

TABLE 1. MEAN RADIANT TEMPERATURES (MRT)* DETERMINED BY A GLOBE THERMOMETER AND BY A DIRECTIONAL RADIOMETER UNDER TWO IDENTICAL SHADES, EL CENTRO, CALIF.

Time	Air temperature, F	Air velocity, fpm	MRT over grass, F		MRT over dirt, F	
			Globe	Radiometer	Globe	Radiometer
7 a.m.	60.0	150	71.0	70.3	72.3	72.3
10 a.m.	85.0	150	86.0	85.6	88.7	88.7
12 m.	85.5	200	88.7	90.7	100.6	97.1
3 p.m.	86.7	450	88.2	87.7	89.7	91.2
6 p.m.	80.3	170	69.1	73.8	75.0	76.7

*Mean radiant temperature with respect to sphere 12 in above ground at center of shadow of shade.

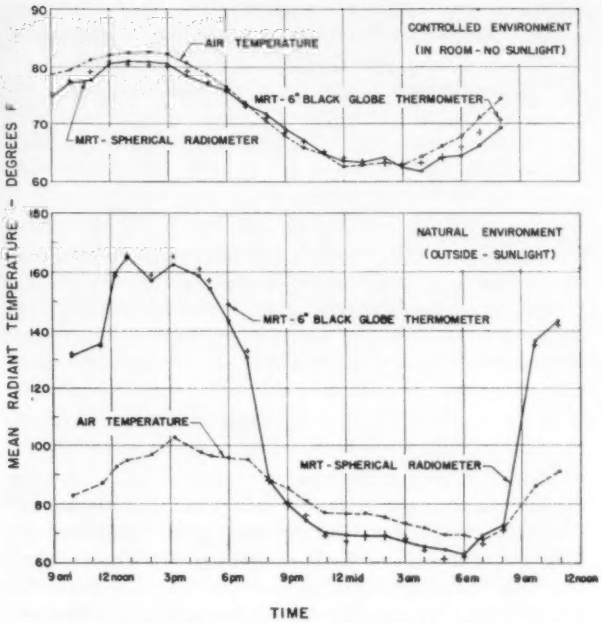

Fig. 3 Comparison of simultaneous determinations of mean radiant temperature in the laboratory (upper section) and outdoors (lower section) with black globe thermometer and spherical radiometer

shown in the upper section of Fig. 3. For a globe thermometer exposed to sunlight in an outside natural environment (lower section of Fig. 3), the temperature difference between globe surface and air is usually large, and it is sometimes difficult to determine wind velocity accurately because of the gusty and unsteady air flow usually encountered under field conditions. An inspection of the globe thermometer equations will show that as the temperature difference between globe and air becomes greater, convection heat exchange increases and inaccurate wind-velocity determinations yield greater errors. With care, good results can be obtained with a globe thermometer exposed to sunlight (see lower section of Fig. 3 for a comparison of mean radiant temperatures determined with globe and with spherical radiometer), but, for comparable accuracy, greater care must be used with a globe in sunlight than with one in shade or in a room.

Description and Characteristics

The globe thermometers used in this project are made from 6-in copper watertrough floats (weight, 12 oz) blackened with two coats of flat black paint. Small holes drilled at opposite points permit insertion of 30-gage copper-constantan thermocouples with the junction at the exact center of the globe. The threaded receptacle attached to the globe makes a convenient connection for hanging the globe or attaching it to a stand. A 30-gage copper-constantan thermocouple is attached at the receptacle so that it measures air temperature about two inches from the globe. For animal environment studies the globe is placed at the approximate level of the center of the animal considered.

The ASHVE Research Technical Advisory Committee (14) has listed the convection coefficients of globes of different sizes (Table 2) for use in equation [2]. The Committee suggests that the changes in convection coefficients are probably negligible as globe diameters exceed 8 in.

TABLE 2. CONVECTION COEFFICIENTS GIVEN BY THE ASHVE RESEARCH TECHNICAL ADVISORY COMMITTEE (14)

Globe diameter	Convection coefficient
2 inches	0.202
3 inches	0.188
4 inches	0.181
6 inches	0.169
8 inches	0.164

The application of these coefficients to globe thermometers in the sun under "field" use was checked by making simultaneous determinations of MRT for five globes of different sizes (Fig. 2) and comparing results with those procured with the spherical radiometer. Mean radiant temperature calculations were made with the convection coefficients of Table 2. These values, as well as the five globe thermometer temperature readings and the spherical radiometer results, are shown in Table 3.

Considering that these tests were conducted in the field (Fig. 2) under fluctuating environmental conditions, the MRT values for the five globes agree well with each other, and with that of the spherical radiometer. The agreement between the 6-in and 8-in globes and the spherical radiometer is particularly good. In view of this agreement, the convection coefficients of Table 2 seem quite applicable, but those for the 6-in and 8-in globes are probably the most reliable. Table 3 shows the increase in temperature with increase in size of globe. This temperature difference was also indicated by Kelly, Bond and Lorenzen (17).

Time Constant. One limitation of a globe thermometer is the time required for it to respond to a change in environment. This reponse time for a 6-in black globe thermometer was investigated. Fig. 4 shows the time constant (time required) for the globe temperature to accomplish 63.2, 95.0, 98.0, 99.0, and 99.9 percent of the total change necessary to establish steady-state conditions at the new environment. If the environment in a room with still air (35 fpm) should be suddenly changed, the globe thermometer would complete 63.2 percent of the necessary change in three minutes, and in 13.5 min would have completed 99.0 percent of this required change. With an increase in air velocity these response times decrease. In the tests, all surfaces surrounding the globe were at air temperature. When additional radiation sources were added, the effect on the time constant was only slight; the response time was shortened somewhat. For this reason the time constants of Fig. 4 are given in terms of air velocity only. Fig. 4 will be of use in determining the time required to obtain a globe thermometer reading of required accuracy. Under most conditions ten minutes should be sufficient. With higher air velocities, this time can be reduced considerably; with globes of greater weight, additional time will be required. Since the time constant is approximately proportional to the weight, for globes of the same diameter and same material, lighter-weight globes will respond more rapidly to changes in environment.

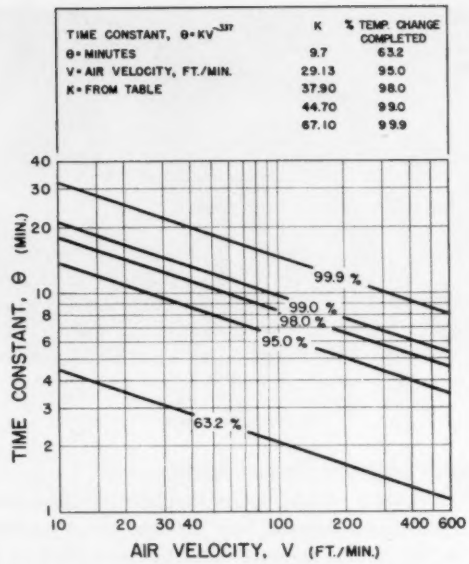

Fig. 4 Graph showing time required, after a change in environment, for the temperature of a 6-in black globe thermometer to complete 63.2, 95.0, 98.0, 99.0, and 99.9 percent of the total change necessary to establish steady state conditions at the new environment

Surface Temperature. The validity, or accuracy, in using a single temperature reading at the center of the globe as representative of the average globe temperature was checked by attaching fourteen 30-gage thermocouples to the inside surface of a 6-in black globe thermometer and measuring the temperatures of fourteen equal surface areas of the sphere. With this globe thermometer in the shade, all thermocouples gave identical readings and the globe surface temperature was the same as that indicated by the center thermocouple. However, with the globe in direct sun there were distinct "hot spots" on the globe surface. Areas most normal to the sun were of course hottest. The fourteen surface areas varied considerably in temperature, with differ-

TABLE 3. SIMULTANEOUS READINGS OF GLOBE THERMOMETER TEMPERATURE, AIR TEMPERATURE, AND AIR VELOCITY WITH CALCULATED VALUES OF MEAN RADIANT TEMPERATURE (MRT) USING CONVECTION COEFFICIENTS OF TABLE 2

(All temperatures in degrees F)

	1:30 p.m.		3:00 p.m.		3:30 p.m.		4:00 p.m.		4:30 p.m.		9:30 p.m.	
	t_g*	MRT	t_g	MRT	t_g	MRT	t_g	MRT	t_g	MRT	t_g	MRT
Spherical radiometer		179.8		172.8		174.2		167.3		167.0		91.8
2-inch globe	136.9	174.2	132.3	165.8	135.2	174.9	131.5	164.3	127.0	160.6	93.1	89.8
4-inch globe	139.6	175.6	135.7	170.1	136.2	173.4	133.5	165.8	129.1	161.9	93.1	90.1
6-inch globe	143.3	181.0	138.0	172.6	137.8	174.2	135.5	167.2	132.4	166.4	93.1	90.4
8-inch globe	144.6	181.7	139.6	174.5	139.0	175.9	136.8	167.3	133.4	167.6	93.1	90.5
10-inch globe	145.4	183.8	142.0	179.3	140.4	178.3	138.9	172.6	134.4	169.6	93.1	90.5
Air temperature, F		108.7		109.5		108.2		107.4		105.5		94.0
Air velocity, fpm		100.0		120.0		125.0		100.0		100.0		400.0

* Globe thermometer temperature

ences of 10 to 14 F between those two areas at opposite points of the globe that were normal to the sun rays. The average of the surface temperatures of seventeen sets of readings was 1.1 F higher than the average temperature at the globe center. Calculating the radiant heat load on the globe from the center temperature would cause an error of only about 1.5 percent. The single center thermocouple reading is certainly to be recommended, and correction can be made for readings in full sunlight if such a degree of accuracy is desired.

Globe Thermometer Application

In the animal environment research project at Davis the black globe thermometer has been applied in several ways to obtain data that would otherwise have been difficult or even impossible to obtain. In studies of swine environment in the psychrometric chamber with 24-hr cycles in room air temperature variation, the temperatures of the air, walls, and floor—and even the pig's surface—are constantly changing, each at a different rate. Here, to define the environment of the chamber accurately, the MRT is highly important and the globe thermometer readings provide a continuously recorded determination of this. In such a room as this, with constant or steady air flow, the globe thermometer functions with good reliability.

In a study of the effect of ground cover on animal environment, four black globe thermometers were used at four locations to determine the MRT of the areas surrounding an animal. Globe thermometers under shades over a pasture field and over a plowed field, and unshaded in the same two fields (Fig. 5) provided values for mean radiant temperatures that were indicative of the animal-comfort levels existing at each of the four locations. These instruments indicated not only the superiority of surrounding grass to dirt (MRT over grass was 12 F less at 12:00 noon) but also showed that a simple shade over either field reduced MRT by as much as 70 F.

In environmental tests with beef cattle in El Centro, Calif., in 1953 (18), it was found that groups of animals fed in an open, wire-fence corral made significantly greater summer gains than animals in a corral pen enclosed by a six-foot plank fence. Since other factors in the tests were equal, this difference in gain was attributed to an environmental difference between the two pens. Globe thermometers at the center of the shadow of the shade at each location showed that radiant heat loads at the wire pens were less by as much as 10 Btu per hr per sq ft of animal surface. The effect on the animals would be equal to that of lowering the air temperature about 4 F. The globe thermometers provided a convenient means of detecting and measuring this environmental difference.

A fourth use was made of globe thermometers in showing the effect of paint in altering the radiation characteristics of shade materials (19). Globe thermometers placed at the shadow centers of three portable flat shades covered with various materials (Fig. 6) determined the radiant heat load that an animal would receive under each of the shade materials. It was shown that aluminum and galvanized iron were substantially improved as shade materials by painting the top side with white paint, and further improved by painting the under side black. The radiant heat load under a white and black painted aluminum shade was as much as 18 Btu per hr per sq ft (of animal surface) less than under a similar unpainted aluminum shade.

Advantages and Limitations

The globe thermometer indicates the combined effects of radiant energy, air temperature, and air velocity—three of the important factors affecting human or animal comfort. It offers a practical and inexpensive means of separating, and quantitatively determining, the radiant energy component of the environment. There is a particular advantage in its low cost and simple construction: recordings from several instruments can be used simultaneously in comparative studies. Negative radiation can be determined as readily as positive radiation. The simplicity of construction, use, and application, together with the reliability of results, makes the globe thermometer an environmental instrument that is adaptable to many agricultural research problems.

The investigations described in this paper suggest some limitations to be considered in its application. It does not account for the evaporative heat loss component, which is a consideration in animal comfort. The response of the instrument is relatively slow and care must be used where environmental factors such as air temperature, air velocity, or radiation are rapidly changing. In direct sun the temperature differential between globe surface and air is great and convection heat transfer is also large, making accurate wind-velocity measurements essential. However, the authors feel that a knowledge of these limitations and care in application should make the globe thermometer a convenient tool in many areas of argicultural research .

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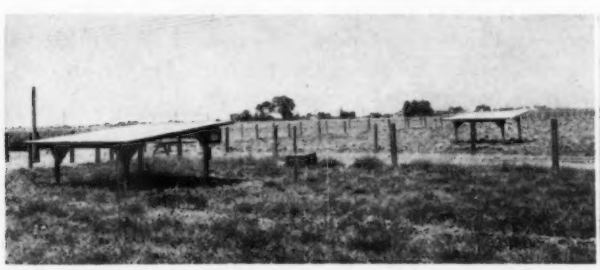

Fig. 5 *(Left)* Black globe thermometers in use to compare MRT's of areas, shaded and unshaded, over pasture (foreground) and over dirt field • Fig. 6 *(Right)* Black globe thermometers at center of shade shadows to compare effect of different shade materials in reducing radiant heat load on globe. Barely visible at center of group of shades is the spherical radiometer, anemometer, and black globe thermometer in sun

Progress in Research Methods and Techniques

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Member ASAE

BECAUSE research and development constitute one of the fastest growing functions in American industry (13)*, it is logical to discuss the topic of research procedure (methods and techniques) with the hope that from the continued consideration of this topic will come more efficient research.

The subject of research methods and techniques should logically be introduced with definitions of the terms with which we are concerned. Many definitions have been considered but the following will apply in this paper: *Science* is systematized knowledge (20). The *scientific method* is the mode by which systematized knowledge is obtained. A *technique* is an experimental manipulation which assists, and sometimes makes possible, the carrying out of the scientific method. There are no general rules governing the formation of experimental techniques.

It has been said (3) that "the objectives in agricultural engineering research (as well as progress in research) are related to our concern with the transition of agricultural practices based on crude observations of nature to new practices depending more on scientific modification of natural conditions—a review of our past research—may reveal limitations in the value of its results."

The author stresses firmly at this point that he is not offering a criticism of past research. Past research was conducted in a manner which primarily was applying currently available knowledge to the fast-changing technology of agriculture. The rapidity and the magnitude of the changes that took place permitted quick application of observations.

It is expected that the research method and technique will depend on the type of research which is to be conducted. Numerous authors have classified research (15, 4, 18), but regardless of the type of research the procedure is "primarily an orderly process for analyzing, planning and conducting an inquiry" (4).

Trends in Research Methods and Techniques

Research methods and techniques have changed greatly in the past 25 to 30 years. Walker (18) presents evidence showing that although agricultural engineering is still an applied field, much more time is being devoted to basic studies such as reduction of wastes, dynamics of units, and unit-operations analyses. Brooks (2) suggests that scientists now are not satisfied until they can generalize their findings by expressing them analytically.

A detailed study and comparison of AGRICULTURAL ENGINEERING for the years 1920-1924 and 1949-1954 further illustrate the changes which have taken place (19). Each article for the year indicated was classified according to the division suggested by Walker, except that some articles of a general non-research nature were omitted. Walker's 1928 survey was concerned only with power and machinery research whereas the study by Wheaton and Kahl (19) attempted to classify all articles appearing in AGRICULTURAL ENGINEERING for the years indicated. A comparison of research distribution is shown in the following table:

The fast-changing technology of agriculture has been responsible in recent years for effecting many of the improvements in research procedure

	Wheaton and Kahl (1920-1924)	Walker (1928)	Wheaton and Kahl (1949-1954)	Walker (Suggested)*
Pure	0	0	0	5
Basic	9	10	21	30
Applied	24	25	44	35
Development	41	25	22	20
Consumer	26	40	13	10
	100	100	100	100

*AGRICULTURAL ENGINEERING, July, 1954.

Admittedly the classifications are arbitrary and no other person would agree with the results in detail. However, the trends will be obvious even to the casual observer.

Administration of Research

The research administrator has a unique and unenviable responsibility. He must be a scientist when working with the researchers, an expert in human relations when dealing with cooperative research projects, and a promotion specialist when seeking funds.

The primary responsibility of an administrator of research is to assemble a staff of great ability and high academic achievement, as well as energy (18). Another responsibility rests on the administrator of research in the universities—that of making sure that a part of the research is fundamental in nature. It is a sin for the non-profit institutions to do research which industry can do (and better) for itself (18). The author is in agreement with Walker's definition of fundamental (pure and basic) research (18) and his suggestions for a percentage allotment for this purpose. The situation may be somewhat different in industry where the emphasis is almost wholly on applied research.

Regardless of whether the research is applied or fundamental, the administrator is responsible for seeing that the researcher prepares an adequate outline showing the objectives, proposed procedure, tentative budget, etc. Such an outline is part of a research method which will contribute to organized and efficient work. The research administrator is also responsible for seeing that the researcher prepares sufficiently frequent and adequate reports.

The Training of Research Workers

The area of training for the research worker represents a very special field for the universities. Experience has convinced at least some of us that the research training should be along basic lines rather than applied, for the requirements of applied training will soon change, whereas the basic training received remains good indefinitely.

Research training at the universities offers opportunity to

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1954, on a program arranged by the Education and Research Division.

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*Numbers in parentheses refer to the appended bibliography.

work either on fundamental or applied projects. It is true that, although the fundamental projects offer a special field for the educational institutions, there are problems of an applied nature which must be solved either because the market is limited (in the case of a specialty machine) or because the problem is at present one outside the field of interest of a particular industry.

The author believes that a research atmosphere is highly desirable, if not absolutely necessary, for the best training of a researcher. One recent graduate student who indicated that he intended to strive for a second advanced degree remarked that his choice was by "infection" rather than by original intent. There is something highly stimulating in an atmosphere of 25 to 30 advanced students each with his own research problem to solve.

A seminar† of industry and engineering education held at Detroit was concerned with the topic "The First Five Years". The theme of the conference was that the critical time in the engineer's development was the first five years after graduation from college. Information presented indicated that, although 80 to 85 percent of the engineers are not engaged in highly technical design or research, the great shortage in the next 10 to 15 years will be in the 15 to 20 percent who are properly trained and are capable of doing the technical design or research. Assuming the validity of this information it is imperative that the universities and/or industry supply the additional training required (11, 12). This may be in company training programs under the guidance of a director of engineering education or it may be in the form of graduate work.

Although the usual suggestion to the colleges is to "add a course" in this or that, those of us who have given considerable thought to curriculum planning know that courses may not be added without taking away from an already overloaded engineering curriculum. We are indebted to Jensen (8) for his suggestion on how to introduce a topic such as experimental stress analysis into existing courses.

McKibben (9), a number of years ago, outlined a plan for successful graduate research training when he wrote "It is most important for the graduate student to take the initiative—in the formulation of plans for the actual research. The duty of the instructor is to furnish a maximum of inspiring and curiosity-arousing guidance and a minimum of detailed and initiative-killing directions." His seven steps for graduate research are essentially those for any complete research project: *(a)* selection of problem, *(b)* survey of literature, *(c)* formulation of plans, *(d)* carrying out of plans, *(e)* analyzing the results, *(f)* interpreting the analysis, and *(g)* publication of findings.

Members of the agricultural engineering department at Michigan State College recently participated in a two-day research seminar for the avowed purpose of finding ways and means to improve the efficiency of the research staff. From their standpoint the conference was a successful one. The general topics covered were: *(a)* outlining the problem, *(b)* reports, *(c)* processing an idea, *(d)* setting up a project, and *(e)* making the project function.

At Michigan State College a practice is followed of regularly scheduled weekly conferences of the graduate-researcher and the major professor. The purpose of this conference is twofold: to keep each other informed as to progress and to furnish a measure of guidance and continuity.

The author would like to differentiate between the training required for design and for research. Proponents of more design courses for agricultural engineers frequently state that such courses would make the student better prepared to do work for a company. This may perhaps be true for those who enter design as a career, but experience shows that few students know exactly what they will be doing or even want to be doing 10 years after leaving school. The engineer who specializes in practical design will be handicapped if he finds himself in research after preparing especially for design. On the other hand, the student who has taken basic courses will be able to adapt himself to design if he should decide that therein lies his field.

Useful Research Techniques

Assuming that we have capable men working on a project, there are certain characteristics of the research worker and certain techniques which seem to be fundamental to all concerned. It is worth while to consider them briefly.

Principles. Certain principles of research have been found to be highly useful (20). First, the researcher should know as much as possible about the object of the research. Second, he should use the most efficient method of detection, and, third, should be able to recognize the object of his search if it is encountered. A search should be systematic and not haphazardly conducted. If possible, one should use a procedure which will converge upon the object sought, and while so doing should consider any effect the search procedure may have on the object being sought.

Bias. The researcher should make a special effort to avoid bias, personal or otherwise, in his research. Deliberate deception is rare in science but self-deception may be all too common.

Research Needed. Some of the state universities have made an attempt to define the potential of geographic areas by certain surveys and studies which emphasize the most important research projects for that particular area. Individual researchers might well follow the same procedure on a smaller scale, in determining the research on which they should be working.

Originality. Originality is rare and whenever possible one should take advantage of it.

The "Instrument News " feature of AGRICULTURAL ENGINEERING occasionally shows unique items of instrumentation which may readily be adapted to other research purposes. Suffice it is to say that we should take advantage of every opportunity to adapt useful techniques to our own research.

Experimental Work. At times it may be necessary to obtain results experimentally rather than to try to develop a theory, because it may be that the theory is inadequate or the labor of performing the theoretical work is great as compared to the experimental procedures required. Later fundamental research may confirm or interpret the experimental work.

Technician Help. In general the researcher who informs the laboratory technician of as much as possible about the job to be done will receive more enthusiastic help with the development of experimental equipment as well as obtaining more accurate observations.

†Relations with Industry. College Industry Conference, Engineering Society of Detroit, January 16, 1954.

Instrumentation and Accuracy. Any researcher should, if possible, keep a set of standard measurements or reference points in order to check the accuracy of the usual measurement means. For instance, certified thermometers are available to calibrate the ones used in regular research. Any instruments which are used should have a response sufficiently fast to determine critical points in an operation if such critical points are suspected to exist. For instance, certain drying tests on grains indicated that cracking was liable to occur at a critical temperature point. It was necessary to establish this point rather closely since it was desired to operate the drier at as high relative humidities and temperatures as possible.

Record Keeping. Such things as notebooks, duplicate copies of data, and pictures and sketches seem rather trivial, but many research projects would be improved if the number and application of these simple items were increased.

Current Information. Research seminars or discussions of current research problems may be useful as a technique in acquainting researchers with latest information concerning the topic on which they are working. In general, the time devoted to these is well worth the while.

Handling Data. In the case of detailed projects requiring the accumulation of a large body of data it may be advisable to use the punched card system for the purpose of recording, sorting and resorting the data in the manner desired. Regardless of the research project, the experimental procedures should be up to date representing the progress and current views on methods and techniques including such items as experimental stress analysis and statistical analysis.

Fundamental Research Projects

The author believes that the primary research duty of the non-profit institutions such as the universities and the U.S. Department of Agriculture should be one of increasing devotion to fundamental research. Problems of this nature are peculiarly well-suited to the universities since the problems, by their very nature, require the cooperation of a large number of branches of science. In the universities this cooperation is readily obtained which makes it possible for them to accomplish the research perhaps easier and cheaper than an industrial concern whose primary function is production. References to the literature indicate that industry men are almost unanimously in agreement with this point (7).

Progress is based on research in the fundamental sciences and certainly there are numerous projects on which the non-profit institutions should be working; for example, the problem of soil compaction. Some work on this problem is being done at our institution as well as at others. This project requires analysis, the theory of which has been only partly developed. Also, some new experimental techniques must be devised in order to measure the magnitude and distribution of the forces involved when a tire passes across the soil. Oother fundamental research might include the utilization of solar energy for home heating, for animal production, and the direct production of electrical energy.

Who defines the problems on which researchers should be working? A very pertinent comment on this was made by Slipher (14), in which he said: "The notion that the agricultural experiment station's place in technology is to solve problems that farmers place before it is a challenge to a true concept of what constitutes research. In the first place, it presumes that problems in agriculture are identical with surface manifestations of trouble, and, secondly, it implies that the farmer is able to identify his problem. The latter is a glorious supposition." Fundamental problems must in general be defined by the personnel who recognize and do research on them.

Summarizing, it seems certain that it is the primary duty of the non-profit institutions to develop the necessary research methods and techniques which go along with the fundamental research which they should be doing. The non-profit institutions are greatly in need of the cooperation of industry in carrying on these projects. The need and manner of cooperation is developed in a later section of this paper.

Division of Research Effort

What percent of a research institution's effort should be devoted to the various kinds of research? Walker (18) suggests that agricultural engineering research should be divided as follows: Pure, 5 percent; basic, 30 percent; applied, 35 percent; development, 20 percent; consumer, 10 percent. This is a significant change from the percentages which he found to exist in a survey in the year 1928.

The individual researcher must also divide his energies on a given project in some manner. Naturally the particular research would affect this division somewhat, but one suggestion‡ to serve as a starting point is as follows: 10 percent literature review and formation of hypothesis; 55 percent instrumentation; 10 percent actual tests (this is the only mechanical part); 10 percent analysis of data; and 15 percent organization and reporting. Actually it is the author's belief that such a distribution might well be followed on a number of projects. In such a distribution it will be noted that only 10 percent of the actual time is assigned to the physical tests. The other 90 percent of the time is assigned to the matter of organizing and analyzing the work; that is about 90 percent devoted to THINKING.

If an individual researcher follows the suggested division of effort, the results will surely be analytical in nature and the findings should be dependable.

Cooperative Research

Increasing Research Efficiency. Some spectacular results were obtained on certain research projects during World War II and without doubt the spectacular results were due to team work of a high order. Team work may be of an intraresearch agency nature, or it may be one of interresearch agency nature. The author is referring specifically to the possibility of cooperative research between industry and non-profit institutions. In this age of extremely complicated research, and recognizing that it will become more so as progress is made, it is necessary that methods and techniques be so organized as to take advantage of the combined abilities of a large number of people. Brooks (2) did some very clear thinking on this subject when he discussed the possibility of project subdivision compatible with transferability of experience and training. To quote: "The customary divisions of science are not due to unique patterns of thought but to the necessity of restricting one man's training to a small enough portion of knowledge to give him some specialized competence."

‡Ban, N. G. Special report in research seminar. Agricultural engineering department, Michigan State College, fall, 1954.

Responsibilities. Development is a primary function of industry (18) the same as fundamental research is a primary function of the non-profit institutions. Closer contact and cooperation is *essential* between these two groups in order that their mutual objective, that of improved agricultural practice, may be attained.

Methods of Cooperation. A number of the industrial concerns have established departments whose primary purpose is to keep abreast of current developments in the field of agriculture. These departments carry on a worth-while activity which serves to keep both groups up to date on new developments in their respective areas of responsibility as well as relieving the non-profit institutions of the necessity of developmental research in favor of the more fundamental kind. In an increasing number of cases the industrial concerns are supporting research at the non-profit institutions by means of grants, fellowships or loans of equipment and services. This seems to be a fine arrangement since it permits an exchange of ideas as well as cooperation in the actual research. However, it should be pointed out that the grants should not be made too restrictive since such restrictions tend to dull the initiative of the researcher. This cooperation was well-expressed by Nichols (10) when he said: "The conception that the information necessary for the solution of agricultural problems must be obtained by groups of scientists working together is fundamentally sound."

Research Reports

Need for Reports. Research accomplished is of little use unless it is reported upon. Reports which are not well organized are inexcusable and one function of the university should be to train the future researchers in proper methods of research reporting. It is recognized that various organizations require different report forms but a certain basic organization of reports seems to be in order.

Special Report Procedures. As an example of special research report writing, the author takes the liberty of giving a little personal experience at his institution. Naturally, as other experiment station workers know, annual reports are required each year on projects which have federal support. These reports are, however, very brief and fall far short of requiring a complete resume of the work which has been accomplished and the research methods and techniques which have been followed. In order to "keep us on the ball" we have instituted the practice of requiring comprehensive annual project progress reports, which are due in the early spring, on each project which is actually in operation in our department. These progress reports are expected to be in detail including pictures, sketches, items of work accomplished, experimental equipment, experimental procedures, review of literature, cost estimates, etc. As long as a project is in active operation, the departmental copy of these progress reports will be available in a central office file so that future researchers may be able to review the work which has been done and thereby to save themselves considerable time and effort.

It is admitted that these progress reports are somewhat of a task, but after having gone through the process for approximately three years, most of the department personnel are of the opinion that the system is essentially sound. Not only does it provide a running and cumulative record of the work methods and techniques which have been followed, but equally important it serves annually to clarify in the individual researcher's mind the work which he is doing and to provide for him an evaluation of his research methods and techniques. A recording of the research methods and techniques may be of equal importance to the record of the research which has been done. Certainly it is most revealing to look back on the work once it has been set down on paper and to compare it with that which the researcher may have visualized accomplishing before the project was started.

The elements of any good project report will include a title, a list of the leaders and cooperators, the object of the research, the procedure, a review of the literature, a description of apparatus, results, suggestions for needed future research and a summary and conclusions. Naturally these may vary from project to project but the essential elements are the same and the author suspects that most of the agricultural engineering departments in the country are acquainting students with the process of report writing when the students take their technical courses in agricultural engineering. Certainly it is true at the institutions with which the author has been associated.

Oral Reports. Research seminars have been previously mentioned. These may consist of research reports either on the individual's own work or on the work of other people which may be of use to him. A topic "Current Problems in Agricultural Engineering" gives an acquaintanceship with other research work. It permits an opportunity to criticize presentation, and tends to clear up in the researcher's own mind the work which he has been doing.

Abstracts. In some of the other scientific fields such as physics and chemistry there are abstracts published annually which bring together short resumes of the work in that field. These abstracts are extremely useful to other researchers and the author wishes to suggest the possibility of such a publication in the agricultural engineering field. Of course this raises the question of financing and of responsibility for the physical performance of such a task. Let us hope it will be given some consideration in the future.

Summary and Conclusions

1 Research and development is one of the fastest growing functions in American industry. Proper research methods and techniques can speed up this development.

2 Research methods and procedures have gone through drastic changes in agricultural engineering in the last 25 years. Trends in research methods and techniques indicate that there will be less of the survey type and more of the basic studies such as reduction of wastes, machine dynamics, and unit operations. More findings are being generalized by expressing them analytically.

3 Surveys, interviews and questionnaires are useful for obtaining a broad understanding of problems.

4 Research methods and techniques may vary, but regardless of the type of research the procedure is primarily an orderly process for analyzing, planning and conducting an inquiry.

5 The research administrator has the responsibility of a proper division of research between fundamental and applied. Research methods and techniques may be interchangeable between these two. In either case, the responsibility of an administrator of research is to assemble staffs of high ability and to provide proper physical facilities.

6 The area of training for the research worker represents a special responsibility for the universities. The research training should be along basic lines rather than applied. The author believes that there is some difference between the training required for design and for research. It is believed that basic courses in mechanics are more desirable for the researcher than applied courses which may soon go out of date.

7 A proper research atmosphere is highly desirable for the best training of a researcher. Cooperation and mutual help are an important part of training in research methods and techniques.

8 Industry should exert a special effort to encourage further training for its engineers during "the first five years" (after they have completed their formal undergraduate schooling).

9 Research seminars, and professional meetings such as the ASAE, offer possibilities for training in research methods and techniques. Formal research seminars permit the administrator to keep his staff informed of specific research methods and techniques as they develop and are recorded in the literature.

10 Simple research techniques include the use of notebooks, pictures, statistical analysis, literature search and proper instrumentation.

11 Fundamental research projects may require the development of new research methods and techniques. Such new developments should be recorded in the literature for the help of other people on other subjects.

12 It is suggested that the largest percentage of time on a research project may well be spent on planning and analysis rather than on the actual tests. The objective is greater efficiency.

13 More and more cooperative industry and non-profit institution research will benefit both parties, since each can most efficiently do its own proper kind.

14 Fairly frequent and complete research reports help to stabilize the individual researcher's thinking as well as to record results and research methods and techniques for future researchers.

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NEWS SECTION

ASAE Officers for 1955-56

THE following new officers of the American Society of Agricultural Engineers were elected as a result of the regular election conducted by letter ballot of its corporate members during February and March, and they will take office at the close of the Society's annual meeting to be held at Urbana, Ill., June 12 to 15:

President—Wayne H. Worthington, director of engineering research, John Deere Waterloo Tractor Works, Waterloo, Iowa

Vice-President (3-year term)—Henry J. Barre, consulting agricultural engineer, Mansfield, Ohio

Councilor (3-year term) — George M. Eveleth, chief engineer, Rock Island Works, J. I. Case Co., Rock Island, Ill.

Nominating Committee — E. L. Barger (chairman), education manager, Ferguson Div., Massey-Harris-Ferguson, Inc., Racine, Wis.; F. P. Hanson, agricultural engineer, Caterpillar Tractor Co., Peoria, Ill., and O. C. French, head, agricultural engineering department, Cornell University, Ithaca, N. Y.

The members of the Council for the Society year 1955-56 will include the above newly-elected officers together with the following: Edwin W. Tanquary and George B. Nutt, past-presidents; J. W. Martin and H. H. Beaty, vice-presidents; H. W. Dearing, Jr. and R. K. Frevert, councilors.

Members of the Society are invited to send any member of the Nominating Committee such suggestions as they may have for nominees for election of officers of the Society in the next annual election of officers which will be held in February and March 1956. It is desirable that such suggestions reach the Nominating Committee on or before June 1, 1955.

Iowa-Illinois Section Meets April 22

THE annual meeting of the Iowa-Illinois Section of the American Society of Agricultural Engineers wil be held in the Quad Cities, Friday, April 22. The meeting will be featured by a plant tour of the J. I. Case Company's works at Bettendorf, Iowa, which will begin at 12:30 p.m. Following the tour at 3:00 p.m., the group will meet at the Blackhawk Hotel in Davenport where, following registration, a technical program will be presented, beginning at 3:45 p.m. The opening number on this program will be a talk by G. D. Johnson of *Successful Farming* on new corn-harvesting methods. Following this two concurrent programs are being arranged, one of which will be of special interest to student agricultural engineers attending the meeting, the subject being agricultural engineering opportunities. The program will open with short talks by S. M. Madill, John Deere Waterloo Tractor Works; Hobart Beresford, Iowa State College, and E. W. Lehman, University of Illinois, and will be followed by general discussion.

The other concurrent program will feature a talk on the Case corn harvester by D. E. Burrough, special engineer, Rock Island Works, J. I. Case Co.

The annual dinner of the Section will be held in the Gold Room of the Blackhawk Hotel at 6:45 p.m. The speaker for the dinner will be the President of ASAE, George B. Nutt, head, agricultural engineering dept., Clemson Agricultural College, Clemson, S. C.

Further information concerning the program and other arrangements for the meeting may be obtained by writing direct to Section Secretary E. G. Rowlett, 2212 E. 12th St., Davenport, Iowa.

ASAE Meetings Calendar

April 22 — MICHIGAN SECTION, General Motors Technical Center, 15 Mile Road (East of Mound), Detroit

April 22 — IOWA-ILLINOIS SECTION, Hotel Blackhawk, Davenport, Iowa

April 22 and 23 — FLORIDA SECTION, University of Florida, Gainesville

May 6 and 7—SOUTHWEST SECTION, Arlington Hotel, Hot Springs, Ark.

May 6 — OHIO SECTION, Ives Hall, Ohio State University, Columbus

June 3-5—TENNESSEE SECTION, Montgomery Bell State Park, Tenn.

June 12 to 15—48th ANNUAL MEETING, University of Illinois, Urbana

August 22-24—NORTH ATLANTIC SECTION, University of Connecticut, Storrs

December 12 to 14 — WINTER MEETING, Edgewater Beach Hotel, Chicago

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Spring Meeting—Michigan Section

THE Michigan Section of the American Society of Agricultural Engineers will hold its spring meeting April 22 at the General Motors Technical Center, Mound Road at 12-Mile Road, Detroit.

Registration for the meeting will begin at 1:00 p.m. in the lobby of the auditorium in the administration building of the Process Development Section.

The technical program will open at 1:30 p.m. with a paper on the fundamentals of materials handling by Sherwood DeForest, assistant editor of *Successful Farming*. This will be followed by a talk on handling potatoes from field to storage by Irving J. Pflug, associate professor of agricultural engineering, Michigan State College.

Blueberry handling and packaging will be the subject of a paper by J. H. Levin, reporting the results of a joint research project conducted by agricultural engineers of the U.S. Department of Agriculture and Michigan State College. As fourth number on the program, B. E. Ryberg, assistant chief engineer, The Farmhand Company, will discuss power handling of feed for livestock.

Following the technical program, the Section will hold its annual business meeting at which the new Section officers for 1955-56 will be introduced.

The annual Section dinner will be held at 6:30 p.m. with K. A. Heade, director of educational relations, division of public relations, General Motors Corp., as master of ceremonies. The dinner speaker will be D. V. Varner, vice-president of Michigan State College, whose subject will be "A Parity Program for All."

Complete information concerning accommodations, etc., for attendance at the meeting may be obtained by writing direct to Section Secretary R. L. Maddex, Agricultural Engineering Bldg., Michigan State College, East Lansing.

A-E Field Days at Ames

TWO agricultural engineering field days to be held at Ames, Iowa on Friday and Saturday, June 3 and 4, have been announced.

The first of these days, referred to as the Technical Field Day, is being arranged for the particular benefit of engineers of the farm equipment industry, farm equipment dealers of the state, specialists in crop drying, and engineers and other specialists of the U.S. Soil Conservation Service.

The second day is the regular agricultural engineering field day for the farmers of Iowa, with a program arranged to cater to their particular interest.

These field days are sponsored by the agricultural engineering department of Iowa State College, and further information concerning them may be obtained from the head of the department, Hobart Beresford.

ASME Celebrates 75th Anniversary

THE American Society of Mechanical Engineers will celebrate its 75th anniversary during 1955. The celebration will be highlighted in meetings throughout the year, each of which will be devoted to a phase of the broad theme: "The Engineer in our World."

The second of the anniversary meetings will be held on the campus of Stevens Institute of Technology, Hoboken, N. J., on April 26 to commemorate the organization meeting of the Society held in the assembly hall at Stevens Institute on April 7, 1880. The particular theme for the program of this meeting will be "The Engineer and the World of Education."

Extension Exhibits at ASAE Annual Meeting

THE Committee on Extension of the American Society of Agricultural Engineers is making elaborate plans for a display of educational exhibits in connection with the Society's 1955 Annual Meeting at Urbana, Ill,. June 12 to 15. The usual blue ribbon awards will be made for winning exhibits in each class. Following are the classes of exhibits that will be accepted:

Motion Picture Films. Awards will be made in two classes of motion pictures—those prepared by commercial organizations and those sponsored by colleges and universities.

Publications. There will be four classes of exhibits of bulletins and periodicals; these include industrial and public agency classes for both bulletins and periodicals.

Slides and Film Strips. This applies to slides and film strips used as teaching aids in extension programs.

Demonstration Models. These will be of two classifications, public agency and industrial or commercial.

Entry forms for educational exhibits may be obtained by writing the ASAE central office at St. Joseph, Mich.

Gravely New Chairman of North Carolina Section

JOHN O. W. GRAVELY, zone manager of the Doolittle Tractor & Implement Co., Charlotte, N. C., was elected the new chairman of the North Carolina Section of the American Society of Agricultural Engineers at a meeting of the Section held March 16 and 17 on the campus of North Carolina State College, Raleigh. He succeeds G. W. Giles, head of the NCSC agricultural engineering department.

The newly elected 1st vice-chairman of the Section is Ray M. Ritchie, Jr., agricultural engineering extension specialist, NCSC, and the new 2nd vice-chairman is James F. Wellons, Jr., rural representative, Virginia Electric Power Co., Roanoke Rapids, N. C.

E. L. Howell, assistant professor of agricultural engineering, NCSC, was elected the new secretary of the Section.

The meeting was closed with the Section's annual business meeting.

Worthington Addresses Fluid Power Meeting

WAYNE H. WORTHINGTON, director of engineering research, John Deere Waterloo Tractor Works, and president-nominate of ASAE for the year 1955-56, was one of the principal speakers at the second annual meeting of the National Fluid Power Association held April 4 to 6 at Broadmoor Hotel, Colorado Springs, Colo.

The theme of the meeting was "Markets and Marketing," a subject of timely interest in this age of rapidly expanding applications of fluid power systems in operations of seemingly unlimited scope.

"Automation" for Ag Engineers

THE sixth of a series of 10 symposiums, on the general subject "Automation—Engineering for Tomorrow," to be presented during the year 1955 at Michigan State College, will be held on May 13 on the MSU campus at East Lansing.

Four outstanding engineering authorities will be featured on the general program: R. W. Bolz, editor of *Automation;* J. B. Cunningham, chief engineer, Wilson Automation Co.; W. G. Baker, vice-president, General Electric Co., and E. A. Walker, dean of engineering, Pennsylvania State University.

During the afternoon of May 13 each department of the school of engineering will sponsor its own concurrent program on a special theme. The program of the agricultural engineering department will feature instrumentation and procedures for research and for the automatic handling of agricultural materials.

A. R. Satullo, The Satullo Engineering Co., Detroit, will discuss the latest instruments and techniques for measuring and controlling automatic processes in research and production. The second speaker will be S. S. DeForest, engineering editor of *Successful Farming,* who has been making a special effort to organize information relating to automatic handling of farm products, will discuss the latest techniques and progress in that field.

A panel will follow these two speakers which, in addition to Mr. Satullo and Mr. DeForest, will include H. J. Barre, director of research, Martin Steel Products Corp., and C. R. Olson, who has his own agricultural engineering consulting service and who is currently chairman of the ASAE Committee on Farm Work Efficiency.

ASAE Annual Meeting Program

THE Meetings Committee has announced the program for the technical and general sessions of the 48th Annual Meeting of the American Society of Agricultural Engineers to be held on the campus of the Univerity of Illinois at Urbana, June 13 to 15. More detailed information concerning the program, accommodations, etc., will be mailed to all members of the Society, and non-members may obtain this information by writing the central office of the Society at St. Joseph, Michigan.

The general sessions of the meeting will be limited to two. The first is scheduled for Tuesday afternoon, June 14. The program at this session will feature the Annual Address of the President of the Society, George B. Nutt, head, agricultural engineering department, Clemson Agricultural College. Following Mr. Nutt's address, the winning paper in the ASAE Student Paper Award competition will be presented. This will be followed by the Annual Business Meeting of the Society.

The ASAE Annual Dinner will be held at 6:30 p.m. of the same day.

Power and Machinery Program

Roy Bainer, chairman of the Power and Machinery Division, will preside at the first session of the Division program on Monday forenoon, June 13. The program will open with a paper on new developments in grain drills by A. G. Buhr, implement engineer, Allis-Chalmers Mfg. Co. T. E. Corley, associate agricultural engineer, Alabama Polytechnic Institute, will follow with a paper on mechanical production of cotton. The final paper of the session will be presented by W. M. Carleton and report on accelerated tests for wear resistance of tillage tools conducted by Carleton and other agricultural engineers at Michigan State College.

The second power and machinery session is scheduled for 10:00 a.m. Tuesday, June 14 at which George M. Eveleth, junior past-chairman of the Division, will preside. I. F. Reed, senior agricultural engineer, USDA Tillage Machinery Laboratory, will open the program with a paper on effects of oversizing tractor tires by two methods. The second paper reports progress in mechanizing the harvest of flue-cured tobacco and will be presented by Robert W. Wilson, engineer, R. H. Bouligny Co., Eugene P. Morgan, divisional engineer, Rockford Works, J. I. Case Co., will present the third paper, on hydraulic sickle drives.

Byron T. Virtue, vice-chairman, Power and Machinery Division, will preside at the third and final power and machinery program session at 9:00 a.m. on Wednesday, June 15. The program will open with a report on recent laboratory studies of shelling corn with combine cylinders by George E. Pickard, University of Illinois. It will be followed by a report on results of work by agricultural engineers at University of Nebraska on adapting the combine for corn harvesting, with L. W. Hurlbut, D. A. Kitchen and Roger Matson as the authors. The third number on this program will be a report on field tests of combines operating in corn in California which has been prepared by John R. Goss, Roy Bainer, R. G. Curley and D. G. Smeltzer of the University of California agricultural engineering department. The concluding feature of the program is to be a symposium on developing attachments for combines used in harvesting corn; the speakers will be C. S. Morrison, chief engineer, product development dept., Deere and Co.; Ray Barkstrom, assistant chief engineer, East Moline Works, International Harvester Co., and C. J. Scranton, chief engineer, Harvester Division, Allis-Chalmers Mfg. Co.

Soil and Water Program

G. O. Schwab, chairman, ASAE Committee on Drainage Research, will preside at the opening session of the soil and water program on Monday forenoon, June 13.

The program will open with a progress report on friction losses in tile junctions by P. W. Manson and Fred W. Blaisdell of the University of Minnesota and U. S. Department of Agriculture, respectively. Truman Goins, Ohio State University agricultural engineer, will follow with a paper on the effects of tile depth and spacing and crops and crop rotations on tile-flow characteristics. This will be followed by a talk on contractors' problems in tile-drainage installations by K. W. Hotchkiss, drainage contractor of Minnesota. The fourth paper on this program will deal with problems in the manufacturing of tile-trenching machines with Thomas W. Schultz, product engineer of Gar Wood Industries, as the speaker. The concluding paper will report surveys for drainage projects and will be presented by L. W. Herndon of the engineering and watershed planning unit of the Soil Conservation Service at Fort Worth, Texas.

At the second session of the soil and water program at 10:00 a.m., Tuesday, June 14, J. R. Carreker, chairman of the Soil Erosion Group, ASAE Soil and Water Division, will preside as chairman. The program will open with a talk on advantages derived from mechanization in erosion control by C. R. Wirthlin, agricultural engineer of The Finn Equipment Co. This will be followed by a summarization and analysis of runoff and soil loss data to be presented by W. H. Wischmeier, analytical statistician of the USDA Agricultural Research Service. The concluding paper on this program will deal with the subject of guides for farm planning in Illinois based on soil conserving rotations and practices, authored by C. A. Van Doren and L. J. Bartelli, respectively, project supervisor, USDA Agricultural Research Service, and state soil scientist of the Soil Conservation Service in Illinois.

The third session of the soil and water program will be held at 9:00 a.m., Wednesday, June 15, with Howard Matson, chairman of the Hydrology Group of the ASAE Soil and Water Division, presiding. D. F. Witherspoon of Ontario Agricultural College will open the program with a paper on characteristics of runoff from small watersheds under winter conditions in Ontario. A new look at small watershed hydrology will be the subject of a paper by H. O. Ogrosky, of the U.S. Soil Conservation Service. F. A. Huff, research meteorologist, Illinois State Water Survey, will next present a paper on comparison of catch of rainfall from various types and sizes of non-recording gages. The concluding number on the program of this session, presented by L. L. Harrold, supervisor of the USDA Soil and Water Conservation Research Project at Coshocton, Ohio, will deal with daily and seasonal evapotranspiration rates for different crops.

A fourth program to be sponsored by the Soil and Water Division is scheduled for

1:30 p.m. on Wednesday, June 15, with Wayne D. Criddle, chairman of the Irrigation Group, ASAE Soil and Water Division, presiding. The first paper on this program, to deal with evaporation losses from sprinklers will be authored by K. R. Frost and H. C. Schwalen of the University of Arizona. The second paper on the program, by D. D. Smith, supervisor of the Soil and Water Conservation Research Project at Columbia, Mo., will consider factors of pond design for the storage of irrigation water. Calculating irrigation requirements of a dairy pasture using climatological data is the subject of a paper by agricultural engineers of the University of Nebraska. The concluding number of the program will deal with designing a subirrigation system, with Roy Fox and J. T. Phelan, engineers of the U.S. Soil Conservation Service, and W. D. Criddle of the Utah State Agricultural College listed as the contributors.

Farm Structures Program

N. H. Curry, junior past-chairman, Farm Structures Division, will preside at the opening session of the farm structures program at 9:30 a.m., Monday, June 13. The program will open with a paper on materials flow on the farm by S. S. DeForest, engineering editor, *Successful Farming*, and this will be followed by a panel discussion on materials-flow problems. The speaker's panel will include Harry Webb, a farmer at Paw Paw, Mich., Wilbur N. Rank, a farmer at Sun Prairie, Wis., and Gene Duncan, a farmer at Malta, Ill. The fourth member of the panel is E. T. Baker of the Baker Agricultural Service at Freeport, Ill.

At the second farm structures session on Tuesday, June 14, R. E. Spelts, Jr., a member of the ASAE Farm Structures Division Steering Committee will preside. The program will open by a talk on selling farm buildings by O. R. Williams of the Indiana Farm Bureau Cooperative Assn. He will be followed by Howard S. Diesslin of the Farm Foundation, Chicago, who will lead a panel discussion on financing farm building construction. The panel will include several other speakers not announced at this writing.

The chairman of the Farm Structures Division, C. H. Jefferson, will preside at the third farm structures session on Wednesday forenoon, June 15. The program will open with a talk on evaluation of farm buildings by B. G. Perkins of the Doane Agricultural Service, and will be followed by a paper on modern trends in dwellings by Norman M. Sweet, an architect of the firm Sweet and Warner Co. The third number on the program will be on buildings integrated with farm production and will be presented by W. H. Yaw of The Farm Clinic, West Lafayette, Ind. The concluding number on this program will be a talk on how he uses farm buildings by James R. Compton, a farmer at Sheffield, Iowa.

At the fourth farm structures session on Wednesday afternoon, June 15, A. C. Dale, Purdue University, will preside. The opening number on the program will be a paper on the design of joints for trusses by W. H. M. Morris of the Purdue University agricultural economics department. This will be followed by a paper by George W. A. Mahoney, Oklahoma A. & M. College on the anchorage of poles for framing farm buildings. Secondary stresses in truss members is the subject of a paper by James S. Boyd of Michigan State College. The concluding number on the program, to be presented by R. B. Fuller, architect, North Carolina State College, will report on research in lightweight tension members for farm building construction.

Rural Electric Program

The first session of the rural electric program is scheduled for 9:30 a.m., Monday, June 13, with W. J. Ridout, Jr., chairman of the ASAE Rural Electric Division, presiding. The entire period will be devoted to a panel discussion of the subject "Utilization of Electricity in the Poultry Enterprise," with Richard Boonstra, research agricultural engineer, Public Service Division, Commonwealth Edison Co., acting as moderator. There will be five speakers on this panel including V. J. Helgren of the Dr. Salsbury Laboratories, discussing air conditioning as related to disease control; Clarence Schroeder, an Illinois poultry farmer, telling about the building of a poultry enterprise with electric mechanization; A. E. Waterman, James Mfg. Co., talking on a basic approach to the poultry ventilation problem; D. J. Bray, Illinois poultry extension specialist, discussing the keeping quality of eggs, and B. J. Brower, Brower Mfg. Co., presenting the equipment manufacturer's viewpoint of the poultry enterprise.

At the second session of the rural electric program, at 10:00 a.m., Tuesday, June 14, H. S. Pringle, vice-chairman, ASAE Rural Electric Division, will preside. The theme of this session will be crop conditioning. The program will open with Carl W. Hall, Michigan State College agricultural engineer, endeavoring to answer the question of whether crop drying is practical for the general farm. The second speaker, K. W. Westerberg, Farm Engineering Sales, Inc., Savage, Minn., will talk on self-feeding from drying systems. The use of natural air for cooling various farm products will next be discussed by A. S. Krenz, president of Krenz and Co. H. F. Mayes, Purdue University ag engineer, will discuss the subject of aeration for the control of moisture migration.

At the third rural electric session at 9:00 a.m. on Wednesday, June 15, R. R. Mauney, a member of the Steering Committee of the ASAE Rural Electric Division, will preside as chairman. The opening number on this program will feature developing interest in a farm electric program through vo-ag teachers by R. L. Maddex, Michigan State College agricultural engineer and P. R. Schepers, farm service supervisor, Consumers Power Co. This will be followed by a report on 4-H electric programs by R. T. Scott, Westinghouse Electric Corp. Demineralizing alkaline farm water supplies using permeable selective membranes and electrical energy is the subject of a paper by E. R. Daniel, Oklahoma A. & M. College. The concluding number on the program by W. C. Krueger, New Jersey extension agricultural engineer, will deal with taking the mystery out of bulk milk cooling and handling.

At the fourth session of the rural electric program, at 1:30 p.m., Wednesday, June 15, W. J. Ridout, Jr., will again preside as chairman. This program will feature farm electrification projects in Illinois and at the University of Illinois. The contributing speakers on this program include E. W. Lehmann, head of the Illinois agricultural engineering department; R. W. Kleis, head of the rural electrification division of the department; F. W. Andrew, extension agricultural engineer, and R. M. Peart, specialist on field research and demonstration programs.

Education and Research Program

F. W. Peikert, chairman, ASAE Education and Research Division, will preside at the Division's opening session at 9:30 a.m., Monday, June 13. The first speaker on this program will be W. T. Spanton of the U.S. Office of Education, who will speak on the relationship of agricultural engineering to Vo-Ag training. How agricultural engineers can meet the needs of the vo-ag teacher will be discussed by G. E. Henderson of the Southern Association of Agricultural Engineers and Vocational Agriculture and E. A. Olson and V. E. Wendorff of the University of Nebraska. Teaching the principles of farm machinery maintenance to students of agriculture will be the concluding number on this program with L. W. Hurlbut and D. A. Kitchen, University of Nebraska, listed as contributors.

The second session of the education and research program is scheduled for 9:00 a.m., Wednesday, June 15, at which F. A. Kummer, vice-chairman, ASAE Education and Research Division, will preside. The first number on the program is the teaching of farm machinery to agricultural engineering students with J. G. Porterfield, Oklahoma, A. & M. College and G. E. Pickard, University of Illinois as the speakers. The third speaker at the session will be Carl W. Hall, Michigan State College, who will discuss the teaching of instrumentation. Carlton M. Edwards, Cornell University extension agricultural engineer, will talk on youth work in agricultural engineering.

Other Program Attractions

In addition to the programs being arranged by the regular five ASAE Divisions the first half of the forenoon of Tuesday, June 14, is being reserved for several concurrent programs and group meetings. These are being arranged by the following:

- Committee on Extension, C. V. Phagan, chairman, presiding
- Committee on Electric Infrared Brooding, J. M. Stanley, chairman, presiding
- Committee on Farm Structures Research, S. A. Witzel, chairman, presiding
- Committee on Nomenclature, Soil and Water Division, John R. Davis, chairman, presiding
- Committee on Evapotranspiration, Hydrology Group, Soil and Water Division, L. L. Harrold, chairman, presiding
- Committee on Interrelationships of Highway and Agricultural Drainage, Drainage Group, Soil and Water Division, Henry N. Luebcke, chairman, presiding
- Committee on Farm Work Efficiency, Carl R. Olson, chairman, presiding
- Surface Drainage Seminar, J. R. Carreker, chairman, Soil Erosion Group, Soil and Water Division, presiding

Student Program

As usual, an elaborate program is being arranged for students enrolled in agricultural engineering curriculums or just graduating from the state agricultural colleges and universities. This program is under the joint sponsorship of the officers of the National Council of ASAE Student Branches and the ASAE Committee on Student Branches.

NEWS OF ASAE MEMBERS

Ben G. Van Zee, chief engineer, automotive division, Minneapolis-Moline Co., was recently elected president of the Internal-Combustion Engine Institute, an organization representing manufacturers in the high-speed gasoline and diesel engine fields with executive office at 201 North Wells St., Chicago, Ill.

BEN G. VAN ZEE

Mr. Van Zee, a native of Iowa, received his BS degree in agricultural engineering from Iowa State College in 1922, and in 1930 received his MS degree from the same institution.

Following graduation from college in 1922, he taught manual training and science for a year at the consolidated school at Morning Sun, Iowa, and he held a similar position for the next five years in the public schools at Mankato, Minn. In 1928-29 he was employed as an agricultural engineer, with major work in drainage, in the Costa Rican division of the United Fruit Co.

In 1929-30 Mr. Van Zee enrolled as a graduate student in agricultural engineering at Iowa State College and during the period of his enrollment was employed as a research fellow in agricultural engineering by the Iowa Agricultural Experiment Station. Upon receiving his master's degree, he entered the employ on July 1, 1930, of the company with which he has since been associated. His beginning work with the company was in the experimental department.

Mr. Van Zee became a member of ASAE in 1922. He served as chairman of the Society's Power and Machinery Division in 1944-45 and is currently a member of the Steering Committee of the Power and Machinery Division. He has been active on other committees of the Society and in the Minnesota Section. He has also been a member of the Society of Automotive Engineers for many years and has played a prominent part in the activities of the SAE Tractor Technical Committee.

Hugh J. Hansen recently resigned as assistant professor of rural electrification on the agricultural engineering staff at Purdue University, to accept appointment as associate editor of *Electricity on the Farm* magazine. Following more than three years of service in World War II with the U.S. Marine Corps as an aviation cadet and fighter pilot, Hansen enrolled at North Dakota Agricultural College and received his BS degree in agricultural engineering in 1951, and his MS degree from Cornell University in 1952. While at Cornell, Mr. Hansen did research work on mechanical handling of chopped forages. His work at Purdue was on projects sponsored by the electric utilities and electric co-ops of Indiana.

Herbert N. Stapleton on February 1 resigned as head of the agricultural engineering department, University of Massachusetts, Amherst, to become agricultural engineer of Shelburne Farms, Shelburne, Vt. Mr. Stapleton had been at University of Massachusetts for 12 years in general charge of agricultural engineering work, prior to which he was for a number of years agricultural engineer of the Green Mountain Power Company in Vermont.

John R. Davis has resigned as instructor in agricultural engineering at Michigan State College to accept appointment as assistant professor of agricultural engineering at Purdue University. He will serve as head of the division of soil and water and will be responsible for the research and teaching activities of that division. He has also been appointed to represent Purdue at the North Central Regional Technical Committee on Small Watersheds.

Phil Norton, vice-president and sales manager, Wisconsin Motor Corp., was recently elected treasurer of the Internal-Combustion Engine Institute. Mr. Norton has been a member of ASAE since 1949. He has been connected with his present employer practically all of his business life and he has been in charge of company sales for the past fifteen years. Mr. Norton enjoys wide acquaintance among engineers of the farm equipment industry.

PHIL NORTON

John W. Brosius, Jr., and his business, Brosius Engineering and Supply Co. of Frederick, Md., are featured in the lead article in the March issue of the *Magazine of Prefabrication*, published by the Prefabricated Home Manufacturers Institute. The story reports among other things that one of his area developments in Frederick has been renamed "Brigadoon" by the residents because they believe it is the happiest community in the United States.

Richard F. Harrington was recently promoted from district engineer to chief development engineer of Aetna Ball and Roller Bearing Company, a division of Parkersburg-Aetna Corp. Mr. Harrington is a mechanical engineering graduate of the University of Alabama, and for three years prior to joining the Aetna organization last year, he was a sales engineer for the Bearings Company of America. In his work for Aetna he has been responsible for the development of a new line of mounted anti-friction bearing units designed specifically for agricultural equipment applications.

R. F. HARRINGTON

Morton W. Bittinger has resigned as instructor in agricultural engineering at Iowa State College to accept employment with the firm of consulting engineers, Collins, Thompson and Willis, Ames, Iowa.

Kenneth V. Anderson recently resigned as managing editor of *Electricity on the Farm* magazine to accept a position in the advertising department of *Better Farming* (formerly *Country Gentleman*). He will be located at the publication's business office in New York City.

John L. McKitrick, formerly extension agricultural engineer, University of Kentucky, and who a few months ago returned from Pakistan where he had been engaged on an FOA assignment, has recently accepted another FOA assignment in Nicaragua where he will work in conjunction with the Institute of Inter-American Affairs.

(Continued on page 266)

NECROLOGY

Howard E. Everett, vice-president and editorial director of Implement and Tractor Publications, passed away March 20 at his home in Kansas City, at the age of 69. Born at Merrill, Michigan, and educated at Washburn University in Topeka, he started his career in journalism with the *Topeka State Journal*, and moved on to the *Kansas City Journal*. This led to his joining the *Implement and Tractor* staff in 1913. In 1916 he compiled a manual on the engineering specifications of various makes of tractors and other farm machinery, which was the basis for the present well-known *Red Tractor Book*. From 1918 to 1929 he was on the editorial staff of *Chilton Tractor Journal* in Philadelphia. Called back to *Implement and Tractor* as editor, he was promoted to general manager in 1940 and to vice-president in 1946.

H. E. EVERETT

A member of ASAE since 1919, Mr. Everett was a familiar figure at meetings of the Power and Machinery Division. His accounts of those meetings helped interpret them to many of the trade who had not been able to attend, and to some who had. He was active in organizing the Mid-Central Section of the Society, and had served a term as its chairman. He was active on the local arrangements committee when the Section was host to the Society's annual meeting at Kansas City in 1952. He was also associated with the Farm Equipment Institute and the Kansas City Implement, Hardware, and Tractor Club.

He is survived by his wife Dorothy, a son Howard E. Everett, Jr., of Coronado, Calif.; three sisters, Mrs. A. A. Bauman, Overland, Ohio; Mrs. Mary Johnrud and Mrs. Margaret Cannon of New York City; two brothers, Robert, of Washington, D. C., and Edward, of New York City, and two grandsons.

Eugene S. Craig, extension specialist in agricultural engineering, University of Idaho, died March 17 at Gritman hospital, at the age of 27. He was born April 12, 1927 in Hollywood, Calif., and graduated from the University of Idaho with a bachelor of science degree in agricultural engineering in 1950. He was instructor in agricultural engineering until June, 1954, when he was employed as extension agricultural engineering specialist for Idaho. He has been a member of the American Society of Agricultural Engineers since graduation and a member of the Pacific Northwest Section. Surviving are his mother, Jennie Craig of Jerome; two sisters, Mrs. R. H. Callen, Jr., Jerome, and Mrs. S. M. Janousek, Mountain Home, Idaho. Services were held March 19. Burial was at Jerome.

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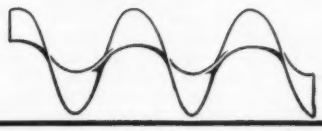
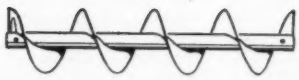
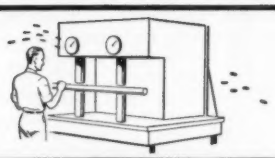
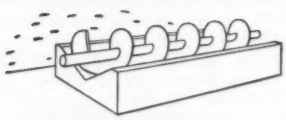
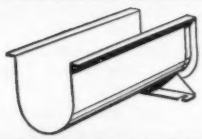
ONE-PIECE HELICOID FLIGHTING		Continuous flighting has greater smoothness and strength. Link-Belt also builds many different types to meet your special needs—cut flight, short pitch, ribbon flight, tapered flight, double flight to name a few.
UNIFORM PITCH		Consistent, accurately-formed flighting is produced by specialized modern machinery.
STEELS THAT MEET OUR SPECIFICATIONS		Selected steel for flighting, assures a uniform, smooth, accurately rolled product.
STRAIGHTNESS		Straightness of the completed auger is checked before shipping. Extra care is taken in handling and loading.
ALL COMPONENTS		A full line of related equipment can be supplied by Link-Belt specially engineered for your requirements. This includes troughs, spouts, hangers, drives.

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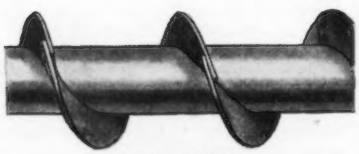
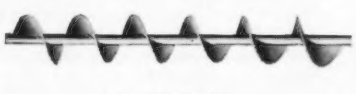


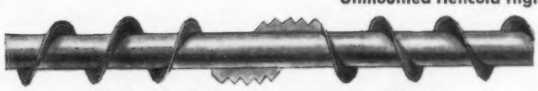
Sectional-flight

Helicoid flight with plain beater



Helicoid flight

Unmounted Helicoid flighting



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News of ASAE Members

(Continued from page 264)

John L. Burgan has retired as director of rural development of The New York State Electric & Gas Company, after having served the company for over 25 years in various capacities. During most of his service with the company, he was engaged in farm electrification on a state-wide basis and was prominently identified with Cornell University and the Edison Electric Institute in farm electrification projects. In addition, he took an active part in the preparation and publication of three important farm handbooks and manuals on farm electrification.

J. L. BURGAN

Mr. Burgan played a leading role in the organization of the farm group of the Edison Electric Institute and has been active in committee work of the Institute for 20 years. He will be retained by his company as a consultant on rural development problems.

In the early years of his business experience, Mr. Burgan worked for the Vinton Colliery and Delano Coal Company at Vintondale, Pa., for 19 years before becoming associated with the Pennsylvania Electric Company, Johnstown, Pa., where he served successfully as supervisor, division manager, and traveling auditor. In 1935 he joined the company from which he is now retiring, as securities manager, and was placed in charge of rural development in the division a few months later. In 1937 he was made director of rural development on a company-wide basis and removed to Ithaca, N. Y.

Mr. Burgan will continue to live at Ithaca with Mrs. Burgan. The Burgans have two sons, Don and Bill, and a daughter, Margaret Burgan Miller, and eight grandchildren. A third son, Jack, who achieved nation-wide fame as a writer, was killed some years ago in an airplane crash.

Lyman H. Hammond, manager of domestic and farm sales, New York State Electric & Gas Company, has been named director of rural development of the company, to succeed John L. Burgan, who is retiring. He has been engaged in rural electrification work during all the years in which he has been associated with the company. He is a veteran of World War I and a graduate of Rensselaer Polytechnic Institute.

L. H. HAMMOND

Mr. Hammond is presently chairman of the Farm Sales Promotion Committee of the Edison Electric Institute, and a member of the advisory committee of the power and machinery division of the Agricultural and Technical Institute at Alfred University and of the New York Farm Electrification Council of the New York State College of Agriculture at Cornell University.

Daniel A. Kitchen has resigned as assistant extension agricultural engineer, University of Nebraska, to accept employment with the National Safety Council of Chicago.

Jack A. Griffin, until recently employed as irrigation specialist with the Soil Conservation Service, U. S. Department of Agriculture, for the next two years will be connected with the United States Operations Mission to Pakistan where he will be serving as FAO agricultural engineering adviser on soil and water conservation. His group is now in process of setting up demonstration projects throughout the country which will be followed by a program of training and field application.

New Critical Occupations List Issued

A NEW revised "List of Currently Essential Activities," published by the U.S. Department of Commerce and a corresponding revision of the "List of Currently Critical Occupations" published by the U. S. Department of Labor were issued by joint release on March 2.

The ten activities listed as essential include ordnance, precision laboratory instruments, production of electronic and communication equipment, production of chemical and allied products, water and sewerage system operation, health and welfare services (including public health), educational services (instruction in mathematics and the physical and biological sciences), and research and development services, of direct concern to the national health, safety or interest.

In the revised "List of Currently Critical Occupations" the classification "Engineer, Professional (all Branches)" is the primary one covering engineers. Functions indicated as included in this classification are (1) engineering research, (2) design of new or improved equipment, structures, machinery, or apparatus, (3) planning and supervising engineering tests, (4) organizing personnel and equipment for production, and (5) other engineering functions of a level of difficulty to require knowledge equivalent to that represented by a bachelor's degree from a four-year professional curriculum in engineering. Explanation under this heading further states that the engineers concerned "may specialize in any of the fields of professional engineering. Typical of the kinds of engineers meant to be included are those listed in the Dictionary of Occupational Titles Code groups 0-14 through 0-20. Included are such titles as Civil, Electrical, Industrial, Mechanical, Metallurgical or Mining Engineer, or other titles listed under these broad designations." (Agricultural Engineer is listed under Mechanical Engineer, 0-19.01.)

Other engineering and related occupations listed as critical are Engineer Draftsman, Design; Geophysicist, Machinist, Mathematician, Physicist; Teacher, College and Vocational (Critical Occupations Only); Teacher, High School (Mathematics and Physical and Biological Sciences Only); and Tool and Die Designer.

The current revisions of the lists are the first made since 1952, and are considerably shortened, reflecting changes in the economic and military situation.

According to the release, "the purpose of the lists is to assist in the equitable distribution of manpower between the armed services and that required for defense production and the civilian economy. The lists are used by the Department of Defense in making determinations for requests for delay on the part of reservists who have been called to active duty. Local draft boards of the Selective Service System also have the lists available for consideration in making determinations on requests for occupational deferment of draft registrants."

Secretary of Commerce Weeks said the criteria used by the committee in reviewing the list of essential activities are as follows:

To qualify for the list under the foreseeable mobilization program, the activity must be one which is:

(1) Necessary to the defense program, or to basic health, safety, or interest;

(2) Inadequate to meet defense and civilian requirements because of manpower shortages or for which the future manpower supply is not reasonably assured.

Secretary of Labor Mitchell said each occupation on the list of currently critical occupations had been determined on the basis of the following criteria:

(1) Under the foreseeable mobilization program an over-all shortage of workers in the occupation exists or is developing which will significantly interfere with effective functioning of industries and activities.

(2) A minimum accelerated training time of two years (or the equivalent in work experience) is necessary to the satisfactory performance of all the major tasks found in the occupation.

(3) The occupation is indispensable to the functioning of the industries or activities in which it occurs.

The revised list of currently critical occupations includes the definitions covering the duties in the specific occupations.

The job definitions found in the Dictionary of Occupational Titles, published by the U. S. Employment Service, have served as the basis for the occupations on the revised list of critical occupations.

The two lists are flexible and recommendations will be made from time to time by the Interagency Advisory Committee on Essential Activities and Critical Occupations to keep the lists current in relation to any future changes in plans for mobilization, the joint statement said.

Requests for information with respect to these lists should be directed to J. Dewey Coates, secretary of the Interagency Advisory Committee on Essential Activities and Critical Occupations, Room 5219, U. S. Department of Labor, Washington 25, D. C.

Agricultural engineers requesting occupational deferment as agricultural engineers under the provisions of these lists should show that they are engaged in one of the listed currently essential activities and refer to the paragraph on Mechanical Engineer in the Department of Labor "Dictionary of Occupational Titles," wherein Agricultural Engineer is specifically named as an application field or subbranch under the Mechanical Engineer classification.

Agricultural engineers will also do well to verify their qualifications as engineers, for authorities not familiar with this branch of engineering, by showing a transcript of college credits, civil service classification, or license as a registered engineer.

According to recent issues of the Engineering and Scientific Manpower Newsletter, the chances of an engineer gaining valuable professional experience in the Army following induction have been considerably reduced by the fact that more engineers have been inducted recently than the Army is able to use in engineering or closely related work.

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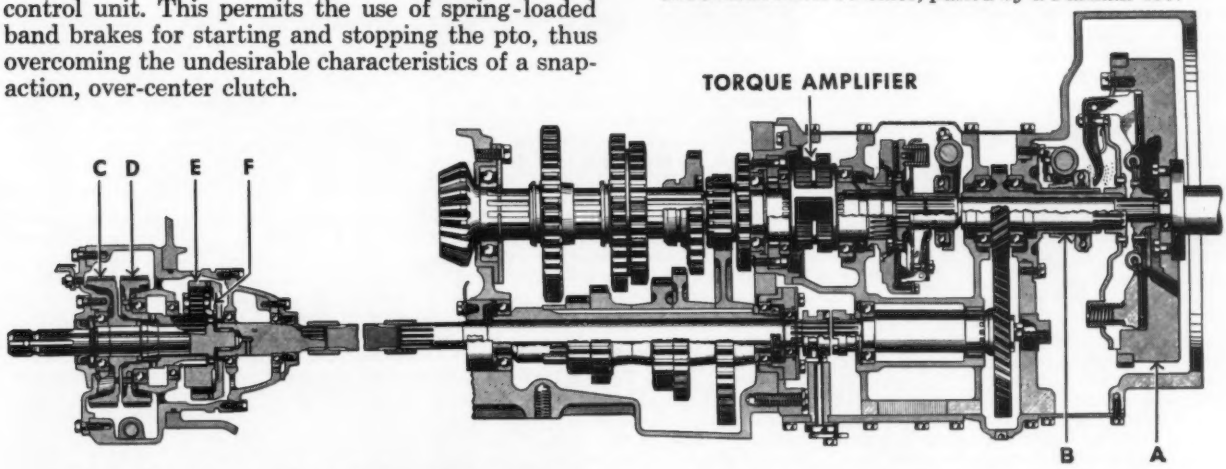
Farmall *completely* independent pto and Torque Amplifier drive team up to eliminate the investment and upkeep costs of mounted engine drives on machines such as this pto-driven big-capacity McCormick No. 55 baler, pulled by a Farmall 400.



Farmall pto is *completely* independent. The pto drive is direct from the engine flywheel (A) and clutch back plate, through hollow shaft (B) to first gear reduction, then to planetary gear reduction and control unit. When the pto shaft is engaged, the brake band (C) on the shaft drum is released, and the brake band (D) on the sun gear drum is applied. This causes the ring gear (E) to turn the planet pinions (F) around the sun gear, driving the pto shaft.

IH engineering teamwork produced the new, *completely* independent power take-off. IH research, engineering, and manufacturing men are constantly pooling time and talent to provide equipment of improved performance, making the work easier, thereby reducing operator fatigue while boosting production.

INTERNATIONAL HARVESTER

International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors . . . Motor Trucks . . . Crawler Tractors and Power Units . . . Refrigerators and Freezers—General Office, Chicago 1, Illinois.

NEW PRODUCTS CATALOGS

New Utility Tractor

International Harvester Co., 180 N. Michigan Ave., Chicago, Ill., last month announced the introduction of its latest model tractor, the International 300 utility tractor, a new, low-profile, all-duty, 3-plow unit

designed to meet all end uses on the farm. The company points out that high traction efficiency is provided in this new tractor through a balanced power-weight ratio and a low center of gravity. Standing 58½ inches high, the International 300 has such features as hydra-touch power control, a versatile hydraulic system, a torque amplifier drive, fast-hitch for quick hitching, unhitching and adjusting of implements, and a power take-off.

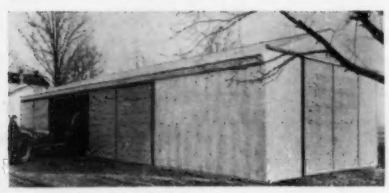
Electric Extension Cord Idea

Racine Specialty Mfg. Co., 1309 State St., Racine, Wis., announces a new product, known as Cord-N-Reel, consisting of a heavy-duty, UL-approved rubber-covered cord on a handy reel that has an electrical outlet built into the reel hub. The outstanding feature of this device is that the

user can get electric current at any point without unwinding the entire cord. It is manufactured in three models. Two models, one with 25-foot and the other with 50-foot cord length, each have a capacity of 7 amperes. The third model has a 50-foot cord and a capacity of 10 amperes. The three models weigh 2, 3 and 4 lb, respectively.

New Steel Farm Building

The Great Lakes Steel Corp., Stran-Steel Div., Ecorse, Detroit 29, Mich., announces an addition to its Quonset line of buildings to be known as the Rigid Frame 28. This new building differs from other farm quonsets in that it is a rigid-framed, straight-sided, and gable-roofed structure rather than of arch-rib construction. The new building is being offered to meet requirements for extra large sidewall doors desired in a building for machinery storage. The basic building is 40 ft long with 20 feet between columns. The length may be increased by any number of additional 20-foot sections. The sides may be left open or enclosed with steel sheets or sliding doors. The endwalls may be solid or equipped with sliding doors for a 14 x 13½-foot opening, walk-in doors and windows.

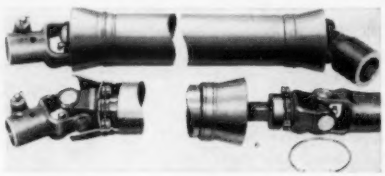


There are no posts or obstructions in the building, which is 16-ft 7 inches to the peak and 12 feet 8 inches to the eaves. Accessories available include walk-in doors, windows, louvers, ventilators, and translucent plastic sheets for skylighting. The exterior is covered with 26-gage corrugated "Seal of Quality" galvanized steel sheets with 2-ounce zinc coating.

PTO Safety Shield

Mechanics Universal Joint Div., Borg-Warner Corp., Rockford, Ill., announces a new safety shield for its universal joints, for use on trucks, tractors, and farm machines, which is now in production and which will be available in all sizes and types for every kind of agricultural implement drive.

The company claims that this new-type safety shield will solve many operating problems because (1) true roller bearings run between the raceway on the joint and the collar in the shield, the rollers being



held in place by a snap ring; (2) the shield more completely covers the joints for protection; (3) there are no welds in the shield, leaving longer overlap of shield tubes (with same length shaft) for greater strength; (4) it can be serviced by the operator with only a screw driver; (5) the shield can be removed to service joints, and (6) it is of open construction, with large rollers, to permit dirt to fall out. The company will supply on request information about sizes, joint types, etc.

Jet Agitator Nozzle

Spraying Systems Co., 3226 Randolph St., Bellwood, Ill., announces that it has designed a jet agitator nozzle (No. 6290) which is positioned near the bottom of the drum of a spray rig to maintain proper mix

and prevent settling and sedimentation of the sprayer chemicals. By means of this nozzle the liquid is sprayed in three directions creating a random agitation pattern that continuously maintains an equalized distribution of chemicals. The design of the nozzle is such that it prevents the setting up of eddy currents and whirlpool action that could hinder the mixing process. The nozzle has been field tested with a variety of solutions and has proved effective. These jet agitator nozzles are supplied in a range of capacities to meet the requirements of all drum sizes and chemicals. In addition, nozzles are supplied in a choice of all brass, brass with stainless steel caps, and in all aluminum as needed by the chemicals used.

New 50-hp Tractor

J. I. Case Co., Racine, Wis., announces its new 400 tractor as the only all-new tractor since World War II in the 50-hp class. With an unbroken range of overlapping gear speeds, the tractor provides any travel speed from a slow creep to road transport, with no gaps. The transmission has eight forward

gears which "overlap" at or above peak-torque engine speed. This permits full use of engine power at any travel speed, which is especially adapted to power take-off machines.

The tractor is powered with either a diesel or gasoline engine. With its 3-point hookup, The Case 400 handles rear-mounted implements of 4-plow, 4-row capacity. The hydraulic system provides for independent or simultaneous operation of two rams—the built-in hitch cylinder and a remote implement cylinder. Another feature of the tractor is hydraulic power steering which furnishes fast, effortless turning.

Catalog on Parallel-Shaft Gear Drives

Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., will send on request to interested readers a copy of its 32-page book (No. 2619) listing 39 standard-size single, double and triple-reduction drives, permitting a standard ration selection from as small as 1.2 to 1 to as large as 323 to 1, with horsepower capacities of over 2,000. The book also contains complete engineering data, including simplified horsepower tables, dimensions and overhung load capacities for selection from the standard line. Baseplates and built-in backstops are also covered.

Ductile Iron Bulletin

The International Nickel Co., Reader's Service Section, 67 Wall St., New York 5, N. Y., will send on request to interested readers a copy of its bulletin (DI-25) "Ductile Iron—The Cast Iron That Can Be Bent," which is profusely illustrated and includes case histories, specification tables for the seven main types of ductile irons and charts comparing mechanical properties. It describes an increasingly popular constructional material, ductile iron, which the company refers to as the engineer's link between the useful properties of cast iron and steel.

(Continued on page 280)

"My steel building cost less than other types of construction and offered so many more extras"

says Leland C. Clark, Elgin, Nebraska

Mr. Clark says he chose his Steel building because "of the low cost and ease of construction." Assisted only by members of his family, working in their spare time, Mr. Clark completely erected his 36' x 80' building in two weeks, and moved in his machinery.

Mr. Clark uses his Steel building for storing machinery and grain. He also has a repair shop in one end. "The sixteen foot doors let us drive in big implements, repair them, and keep them under cover," he says. At present he is storing three tractors, a corn picker and a combine, in addition to numerous other implements in his Steel building, *plus* 1,070 bushels of ear corn.

"I'm so completely satisfied with my Steel building," adds Mr. Clark, "that I plan to erect another to replace a wood barn that recently burned to the ground. Fire safety is another reason for my changing to Steel buildings on my farm."

For dairy cattle housing, grain and machinery storage, Steel buildings are ideal. They are big, strong, roomy, tight and dry, fire-resistant and easily grounded against lightning. And you'll save plenty on erection costs and upkeep when you invest in a Factory-Built Steel Farm Building manufactured with long-lasting USS Galvanized Steel Sheets for roof and walls, and a USS Structural Steel framework.

When buying a Factory-Built Steel Farm Building, ask for USS Galvanized Steel Sheets for roof and sides. These sheets have a zinc coating produced to ASTM Specification A-361. This is your assurance of a high quality building.

SEND THIS COUPON FOR FURTHER INFORMATION

Agricultural Extension Section, United States Steel Corporation
Room 4652, 525 William Penn Place, Pittsburgh 30, Pa.

I am interested in steel buildings for the following:

☐ machinery storage ☐ grain storage ☐ poultry houses
☐ hay storage ☐ dairy barns ☐ cattle shelters
☐ other .....

Approximate size or capacity .....

☐ Please have a Steel Building representative call on me with further information. Send information to:

Name.....

Address..... Town.....

County..... State.....

United States Steel Corporation produces high-quality USS Galvanized Sheets and Structural Steel which our customers manufacture into durable farm buildings. Your requests for information will be forwarded to the manufacturers of these buildings, and you will hear directly from them.

USS

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

International Harvester Company Farmall Cub Tractor does a discing job—one of its many round-the-clock spring season tasks.

To make a tractor engine run better longer ...*specify* PUROLATOR

On farms throughout the country, a tractor is an economic necessity.

From dawn to dusk—often on through the night—today's "steel horses" keep hard at it—often in fields clouded with dust.

A breakdown, a few hours' delay—at planting or harvesting time—can seriously affect the farmer's entire year's profits.

Tractor makers know this! That is why they give top attention to lubrication systems; why efficient oil filtration is a "must" in today's tractor engine design.

PUROLATOR
WORLD'S FINEST OIL FILTER

5 reasons why more major tractor manufacturers specify Purolator-built filters and refills than any other make

1. Purolator's famous "accordion-pleated" Micronic filter element has *up to ten times more filtering area than ordinary types.*

2. Electron micro-photographs prove that Purolator Micronic filters stop harmful particles microscopically small from reaching delicate engine parts.

3. The pleated design of the Purolator Micronic filter element provides *many times more dirt storage space than old-style filters.*

4. With its larger filtering area, the Purolator Micronic filter element introduces a remarkably small pressure drop into the lubricating system . . . *permitting pumps of practical size and simple type.*

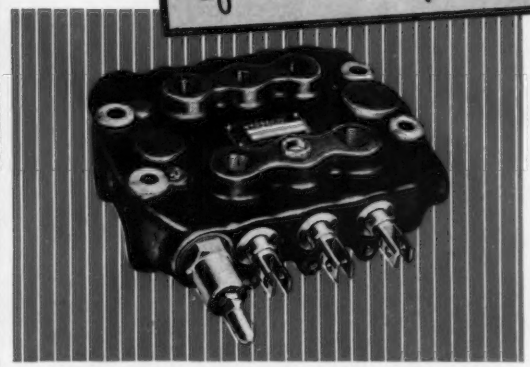
5. With Purolator Micronic Filtration, the tractor operator keeps all the oil quality he pays for. *The Micronic filter element will not strip additives . . . an important advantage with H.D. and heat-resistant oils.*

For further information write, wire or phone:
PUROLATOR PRODUCTS, INC.
Rahway, New Jersey and Toronto, Ontario, Canada.
Factory Branch Offices: Chicago, Detroit, Los Angeles

"Purolator," "Micronic," Reg. U. S. Pat. Off.

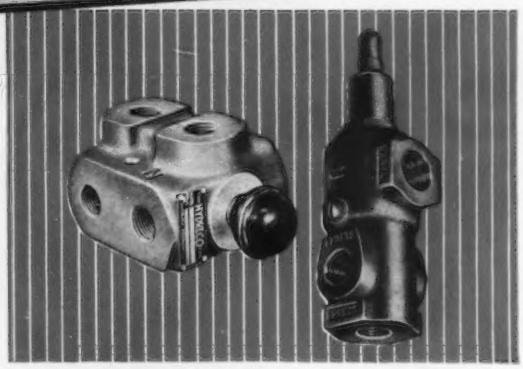
PUMPS
CYLINDERS
VALVES
MOTORS
ENGINEER'G

Mr. Hydraulics Engineer—
We suggest that you'll want to be familiar with these important developments in Fluid Power . . . products of The New York Air Brake Co.



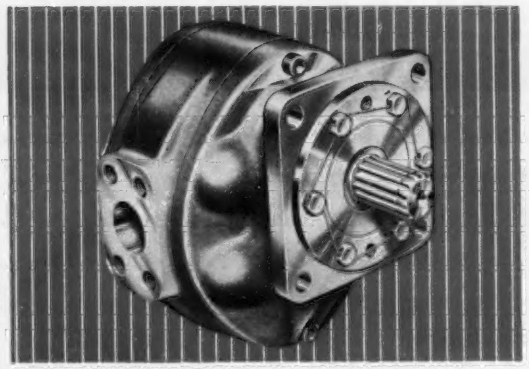
HYDRECO HOLLOW-PLUNGER CONTROL VALVES

The advancements made by HYDRECO engineering in multiple plunger, single and double acting control valves bring you new, accurate throttling . . . smooth, positive, fingertip control with notable freedom from binding, chattering or troublesome back pressures. Valves with 1 to 5 plungers in capacities from 5 to 80 gpm and operating pressures of 1500 and 2000 psi are now available for your present and projected equipment.



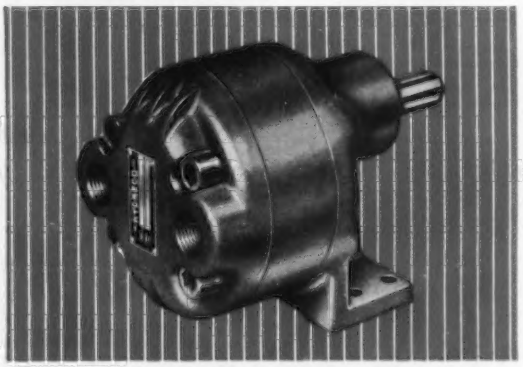
HYDRECO AUXILIARY VALVES 1000/2000 psi

HYDRECO engineers have made very important contributions to the modern hydraulic system in the Relief and Selector Valves now available for your applications. For accurate control over a long service life, HYDRECO Relief Valves in capacities to 80 gpm serve without chatter, squeal or whistle. The Selector Valves enable you to perform additional operations with your system, and these are available in capacities to 50 gpm.



HYDRECO GEAR-TYPE PUMPS 1000/1500 psi

HYDRECO engineers have shattered the illusion that "any gear pump is just a gear pump". New developments in the famous HYDRECO Four-Bolt design provide higher pressures, higher speeds and higher efficiencies than were previously available. You'll want to know more about the many Heavy Duty features in HYDRECO Pumps. A full range of sizes — 3.3 to 55 gpm at 1200 rpm, 1000 psi.



HYDRECO FLUID POWER MOTORS 1000 psi

For the many applications which call for reversible rotary motion with high starting and running torques...HYDRECO Four-Bolt, Gear-Type Fluid Motors are the economical and reliable answer. Precision, ruggedness and simplicity combine to ideally suit these motors to farm equipment, conveyors, winches and hundreds of other uses. Sizes 3 to 17 hp at 2000 rpm, 1000 psi.

Bring your Hydraulics Data up-to-date . . . Write for your FREE Bulletins on HYDRECO Pumps, Motors, Valves and Cylinders TODAY!

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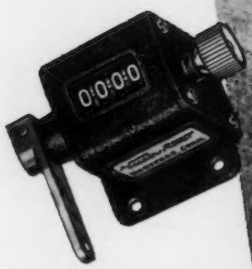
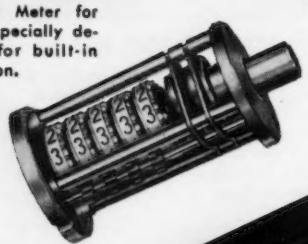


Small Reset Ratchet Counter for Hay Balers.

Rev-Hour Meter for tractors, specially designed for built-in installation.

Rev-Hour Meter for tractors specially designed for built-in installation.



Veeder-Root A type of Rev-Hour Meter for tractors . . . a self-contained unit for built-in application.

Revolution Counter for recording acreage seeded by grain drills.

No. 21 Speed Counter for taking rpm of rotating shafts on your combines, on power take-offs, etc.

Hand Tally for counting livestock, poles, shrubs, trees, etc.

More and More Farm Equipment users say

"Build it so we can COUNT ON IT!"

Veeder-Root Agricultural Counters built into tractors and other equipment tell "how many", "how long" and *"HOW GOOD."* They safeguard manufacturers, dealers and users because of the trustworthy performance records they provide. If *you* have something to count, there's a Veeder-Root Counter that will do the job.

VEEDER-ROOT INC.

"The Name That Counts"

HARTFORD 2, CONNECTICUT

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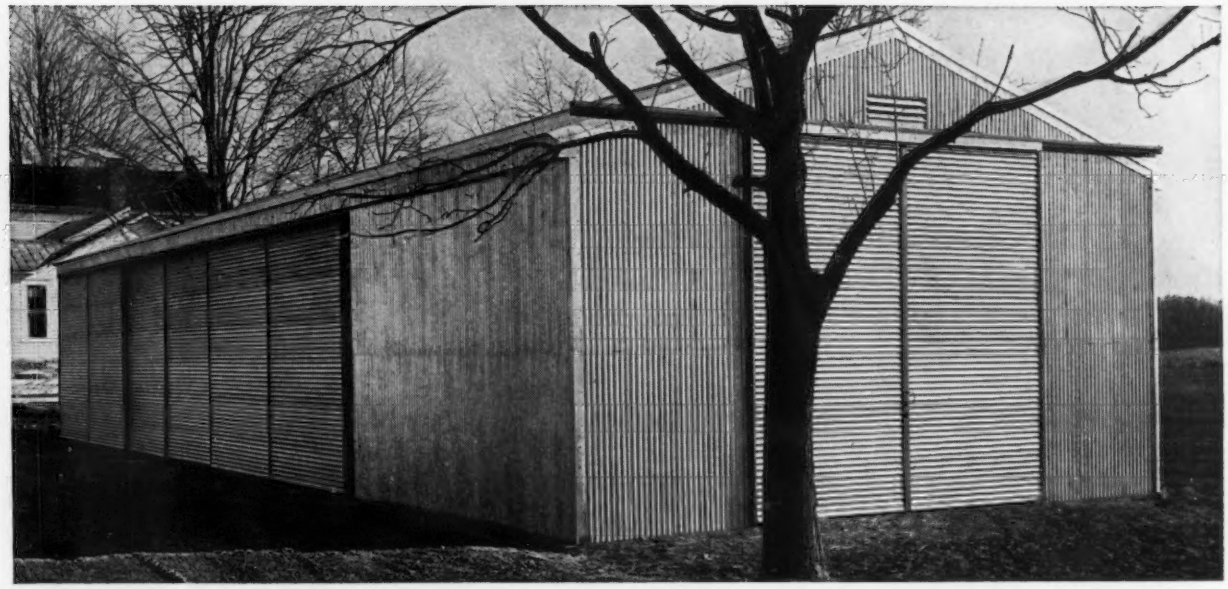
Tel: STate 2-6283



Another QUONSET® *FIRST* for farmers!

The ALL-NEW RIGID-FRAME 28

A straight-sidewall addition to the famous Quonset line, engineered specifically for farm use.

Check these important features of the RIGID-FRAME 28 Quonset building.

Louver—a 37″ x 14″ steel louver is supplied as standard equipment in endwalls with 14′ x 13′-6″ door, and in solid endwalls.

Sliding Doors—Two sizes of sliding steel doors are available—the 14′ x 13′-6″ sliding door for use in endwalls, and the 20′ x 12′ sliding door for sidewalls.

Walk Door—A 3′-6″ x 7′ swing steel walk door is available for use in either endwalls or sidewalls.

Windows—Four-light windows are available for both endwall and sidewall installations.

Post-Free Interior—Sliding sidewall and endwall doors offer maximum maneuverability of farm equipment.

Skylighting—Corrugated translucent plastic roof panel. Several colors are available.

Roof Ventilation—20″ galvanized steel roof ventilators with dampers are available as an accessory.

Paint—Quon-Kote paint, specially formulated for use with galvanized steel, is available in any of five harmonizing colors.

Insulation—The RF-28 can be insulated economically with either board, blanket or bat type material.

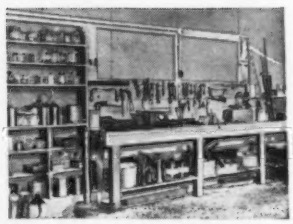
Unique Nailable Framing Members—Nails driven through collateral material into the nailing groove are deformed and clinched in a grip of steel—much stronger than the holding power of conventional materials.

Erection—Pre-cut to exact lengths punched for assembly with self-threading screws means minimum erection time. Either complete erection service or erection supervision is available through your Quonset dealer.

"Seal of Quality"—26-gauge steel sheets, galvanized with 2-oz. zinc coating for longer life and greater corrosion resistance.

Floor—Building is designed with piers for dirt floor, but plans are provided for partial or complete concrete floor if desired. The RF-28, and all buildings in the Quonset line for farm use, are easily financed on the Quonset Purchase Plan. See your Quonset Dealer.

Post-free interior and large, easy-to-slide doors in end and sides make the Rigid-Frame 28 ideal for efficient farm machinery storage. The enclosed end can be insulated to provide a complete farm shop.



A completely insulated handy farm shop such as this makes machinery maintenance and repair a comfortable job any time of the year. A 20-foot door in the shop sidewall admits even the widest machinery.

An economical hay storage and self feeding barn which serves as additional shelter as cows eat their way in. This adaptation of the Rigid-Frame 28 also provides extra machinery storage or utility space.

Used as a loose-housing barn, the Rigid-Frame 28 is roomy, and its post-free interior makes it easy to clean with power equipment. One end can be enclosed and insulated as a milking parlor and milk house.

Stran-Steel Division

GREAT LAKES STEEL CORPORATION

Ecorse, Detroit 29, Mich. • A Unit of

NATIONAL STEEL CORPORATION

YOU MAY AS WELL STRAN STEEL FRAMING

STRAN STEEL AND QUONSET REG. U.S. PAT. OFF

PRODUCER OF N-A-X HIGH-TENSILE STEEL

GREAT LAKES STEEL CORP.,
Stran-Steel Div., Detroit 29, Mich.

Please send me the latest literature on Quonsets for farm service buildings and the name and address of my nearest Quonset dealer.

Name_____

Address_____

City and County_____ State_____ 43

Homemade Weed Clipper

KEEPS FENCE ROWS CLEAR

BOB GOETZE and his brother decided to clear out the weeds and tall grass along the fence rows on their farm. So they built a fence row clipper from some angle iron and odd metal found around the farm and mounted it on bicycle wheels. It is powered by a 3-h.p. engine. A pulley from a combine is mounted on the drive shaft with grease fittings in babbitt bearings for Marfak lubrication. A small wheel from an old coaster wagon runs next to the fence to keep the blade at a proper distance. The Goetzes, like keen farmers and ranchers from coast to coast, have found that *it pays to farm with Texaco products.*

Bob Goetze, of South Pekin, Illinois, shows Texaco Man Byron Ansorge *(right)* weed clipper which Bob and his brother made. Bearings are protected against wear with Marfak lubricant. Marfak forms a collar around open bearings, seals out moisture and grit.

Les Gilman *(center)* operates a farm and dairy near Medford, Oregon; delivers milk products to 1400 accounts. It's a stop-and-go truck operation. He finds Advanced Custom-Made Havoline Motor Oil keeps engines from sludging, valves from sticking. Texaco Consignee Ken Teeter *(right)* explains Havoline out-performs them all regardless of price. Texaco Driver Jack Rose is shown on left.

Mr. M. S. Knowlton *(left)* **who has a 3500-acre plantation** near Perthshire, Mississippi, receives a friendly visit from Texaco Consignee C. M. Shaw, Jr., of Shelby. Texaco distributors and consignees give timely, neighborly service that farmers and ranchers appreciate. Mr. Shaw has just delivered a tankful of Fire Chief, the gasoline with superior *"Fire-Power"* for low-cost operation.

Self-propelled grain cart for soggy fields. Byron D. Webb *(right),* rice farmer of Hamshire, Texas, gives bearings the sure protection of Marfak lubricant as Texaco Consignee D. S. Spidle, of Beaumont, looks on. Marfak forms a collar around bearings, seals out dirt and moisture, prevents rusting; won't wash off, jar off, drip out or cake up.

☆ **And in Town or on Highway . . .** the Texaco red star and green "T" is the sign of service. Only Texaco Dealers have new top octane Sky Chief gasoline, Super-Charged with Petrox, to give maximum power and reduce engine wear . . . famous Fire Chief at *regular* gasoline prices, both 100 per cent *Climate-Controlled* for top performance . . . Advanced Custom-Made Havoline and Marfak lubricant.

TEXACO
REG. T.M.
THE TEXAS COMPANY

ON FARM AND HIGHWAY IT PAYS TO USE TEXACO PRODUCTS

DIVISION OFFICES: Atlanta, Ga.; Boston 16, Mass.; Buffalo 9, N. Y.; Butte, Mont; Chicago 4, Ill.; Dallas 2, Tex.; Denver 3, Colo.; Houston 2, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 3, Minn.; New Orleans 16, La.; New York 17, N. Y.; Norfolk 10, Va.; Seattle 1, Wash.

Texaco Petroleum Products are Manufactured and Distributed in Canada by McColl-Frontenac Oil Company Limited.

Ni-Resist crop sprayer pump impeller, used for 3½ seasons handling over 5 million gallons of corrosive and erosive insecticide slurry. And as you can see, it is still in good condition.

Bronze casing for insecticide spray pump, above, failed badly after 8 hours in accelerated erosion test, while Ni-Resist casing below, is still good after 20 hours similar service. Casings produced in Type 2 Ni-Resist.

Typical examples, showing spray pump applications, from the new NI-RESIST booklet

Ni-Resist outlasts bronze from 8 to 20 times in spray pump service

These illustrations bring out some of the advantages of using Ni-Resist in farm equipment.

Ni-Resist withstands not only corrosive attacks of acids, alkalies and salts, but it also resists galling and metal-to-metal wear. In fact, no other cast metal provides such a unique combination of useful engineering properties. So investigate how Ni-Resist can help you. Read the new Ni-Resist booklet.

64-page revised edition . . . yours for the asking. From cover to cover, this booklet is full of pictures, data, charts . . . showing how Ni-Resist stands the gaff. It's probably exactly what you've wanted. Send for your copy . . . fill in the handy coupon, now.

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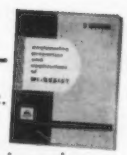

The International Nickel Company, Inc.
69 Wall Street, New York 5, N. Y.

Please send me booklet entitled "Engineering Properties and Applications of Ni-Resist."

Name_____

Title_____

Company_____

Address_____

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THE INTERNATIONAL NICKEL COMPANY, INC. 69 Wall Street New York 5, N. Y.

"HANDS" THAT HELP MOVE THE EARTH!

. . . those unseen hands that put action into the earth moving giants . . . the hundreds of shapes and sizes of steel castings that make up excavating and mining machinery. Hands that are unnoticed and are subject to shock, stress and abrasion . . . all examples of Unitcasting's dependability.

Gears, cams, rockers, sheaves, stanchions, levers, protective housings, and many other parts made to exacting standards . . . subject to rigid inspections. Foundry engineered Unitcastings are the answer when the going gets rough!

Assured dependability in parts? Specify Unitcastings! Unitcast's representative is as convenient as your telephone. Call today!

UNITCAST CORPORATION • Toledo 9, Ohio

In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

QUALITY STEEL CASTINGS

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Albright, Wm. V. — Agricultural engineer (FHA), USDA, South Bldg., Washington 25, D. C.

Barrows, John W.—District service supervisor, International Harvester Co., 409 Lock St., Cincinnati 2, Ohio

Bender, Leo H.—Research assistant, Ohio Agricultural Experiment Station. (Mail) 2672 Wallings, W., Cleveland 29, Ohio

Bodine, William S.—Special representative, Euclid Machinery Div., General Motors Corp., Cleveland 32, Ohio. (Mail) 25611 Lakeshore Blvd.

Burns, Pete Y.—Product planning, Tractor & Implement Div., Ford Motor Co., 2500 E. Maple Rd., Birmingham, Mich.

Chambliss, Jesse G. Jr.—Associate professor in agricultural engineering, Abraham Baldwin Agricultural College, Tifton, Ga. (Mail) Abac Rural Station

Dalglish, James J.—General manager, Republic Engineering & Manufacturing Co., St. Paul, Minn. (Mail) 1831 Ashland Ave.

Durant, William C.—Extension agricultural engineer, New Brunswick Department of Agriculture, Fredericton, N. B., Canada. (Mail) 446 Water St.

Ephrat, Alexander H. — Instructor in farm mechanization, Jordan Valley Agro-Technical High School. (Mail) Afikim, Jordan Valley, Israel

Fast, Robert E.—Farmer, Carroll, Ohio

Fenster, Abraham S.—Advanced designer, advanced engineering dept., International Harvester Co., 2919 S. Western Ave., Chicago 8, Ill.

Frayer, Clyde C. — Salesman, engineering dept., Southern Irrigation Co., Memphis, Tenn. (Mail) 4404 Auburn Rd.

Haun, John W.—Director of engineering, Brillion Iron Works, Inc., 200 Park Ave., Brillion, Wis.

Herndon, Louis W. — Drainage engineer (SCS), USDA, Fort Worth 15, Tex. (Mail) 3267 Fuller St.

King, Richard J. — Design draftsman, J. I. Case Co., Rockford, Ill. (Mail) 1304 LaBelle Ave.

Kramer, Richard W.—Product designer, International Harvester Co., 1250 S. Wilson Way, Stockton, Calif.

Lackie, Arnold—Lecturer in agricultural engineering, Harper Adams Agricultural College. (Mail) The Farm Institute, Caythorpe Court, No. Grantham, Lincolnshire, England

Lindsay, H. W. — Works manager, Allis-Chalmers Mfg. Co., LaPorte, Ind. (Mail) 1902 Indiana Ave.

McAninch, Herbert A. — Vice-president in charge of engineering, Warner Automotive Parts Div., Borg-Warner Corp., Auburn, Ind.

McComb, John F.—President, The McRan Co., PO Box 6746, Houston 5, Tex.

McCullough, Helen E.—Assistant professor in home economics and housing research, University of Illinois, Urbana, Ill.

(Continued on page 278)

BURLAP BULLETIN

News about packaging and agricultural and industrial developments in burlap

ANY OF THIS MATERIAL MAY BE REPRODUCED WITHOUT PERMISSION.

Worth Watching

Keep your eye on the popular 50-lb. burlap potato bag which is becoming a favorite with more and more shippers all over the country. In an effort to provide a strong lighter-weight bag at a still lower cost, the Indian Jute Mills Association has supplied The Burlap Council with seven lightweight fabrics which are now being tested in this country. Bag manufacturers and potato shippers are presently testing these lighter fabrics in actual use.

Laminated Burlap Bags Solve Tough Packaging Problems

Hydroscopic substances and other materials which require special protection from the elements can now be shipped safely in laminated burlap bags, which are made of laminated sheets of burlap and polyethylene.

Bemis Brother Bag Company, world's largest bag manufacturer, has pioneered this new and versatile container which has proved highly satisfactory for packaging flour, salt, sugar, meal, feeds, minerals, drugs and insecticides.

These laminated burlap bags are being adopted for various products which were formerly shipped in cans or drums. These can now be packed in this new-type lightweight flexible bag, which not only makes for easier handling but saves in freight expense as well.

Here is another instance where burlap, combined with other materials, does an unusual job to serve American agriculture and industry.

Attention Agricultural Engineers and County Agents:

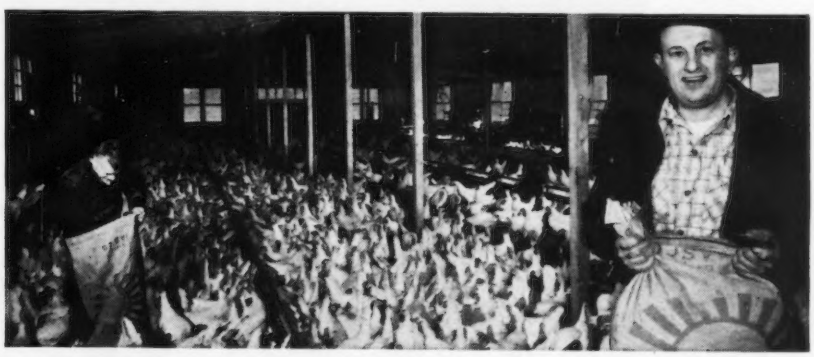
Help maintain a 2-way flow of information by 1) telling us about the unusual and interesting uses of burlap in your area and by 2) writing us about the projects and problems you are presently concerned about in which burlap might play a role. That's what our technical development and research laboratories are for. *Write to* William A. Nugent, Vice President, The Burlap Council, 155 East 44th Street, New York 17, N. Y.

GRASS-ROOTS SURVEY DIGS UP FACTS ABOUT BURLAP

Farmers Tell Photographers What They Think About Burlap Bags

Interstate Photographers, an independent organization which was engaged by The Burlap Council to photograph actual farm scenes of burlap in use in Texas, Maryland, New Jersey, Colorado, Georgia, North Carolina, and Florida, collected a score of interesting comments made by the farmers. These have formed the basis of a series of factual advertisements in an unusual "let the farmer write the ads" campaign. Ads will appear in Better Farming, Progressive Farmer, Capper's Farmer, Poultry Tribune, Agricultural Chemicals, Farm Chemicals, Feed Age, Feedstuffs, Canadian Milling, Cooperative Digest, and The Packer.

This ad in Better Farming is one of the "let the farmer write the ads" series.



The Poultryman's viewpoint was expressed by Morris Plevan, managing partner of a large New Jersey farm shown above. He is a graduate of The New Jersey College of Agriculture (Rutgers University) and Phi Beta Kappa, a former Director of Applied Agriculture and Professor at the National Agricultural College at Bucks County, Pa.

For the efficient economical operation of his farm, Mr. Plevan insists on burlap bags when he purchases feed. Empty burlap bags are of great use around the farm, he reports — for insulation, shading of poults, and in repairs to the roofs of 20 poultry houses. He makes his own built-up roofs with used burlap bags and hot asphalt, substituting the burlap for the usual built-up felts. The burlap, of course, is protected by the usual asphalt coatings. This type of roof is more serviceable than other roofing material because the burlap does not crack, and in general stands up better. With burlap, repair work is easier and less expensive than other patching.

With ordinary roll roofing, heat and cold pull nails. By applying a strip of burlap over the nail heads and sealing it in place with the asphalt, this troublesome problem is controlled

Published by The Burlap Council of the Indian Jute Mills Association
155 East 44th Street, New York 17, N. Y.

STOW flexible shafting ON THE JOB

pumping GAS on a tractor-trailer

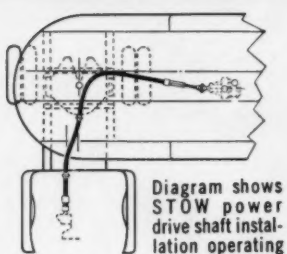


Diagram shows STOW power drive shaft installation operating through 90° bend.

STOW Flexible Shafts have effectively solved power take-off problems on both trucks and tractor-trailers. Large shafts, such as the 1¼" pictured above which transmits up to 10 H.P., have proven their ability on power take-off applications more efficiently and with more trouble-free service... **to operate pumps** for petroleum, milk and other liquids; **to operate conveyors** for grain, coal; **to operate compressors** on refrigeration trucks.

Why not put Stow to work on your power drive problems? Stow Engineers are always at your service.

For complete engineering data and illustrations on STOW Flexible Shafting—Write today for FREE Bulletin 525.

Write today for Bulletin 542 and complete data on Power Take-Off drives.

STOW MANUFACTURING CO.
39 SHEAR ST., BINGHAMTON, N. Y.

Applicants for Membership

(Continued from page 276)

McFarlane, Redvers J. — Market analyst, Massey-Harris-Ferguson, Ltd., Toronto, Ont., Canada. (Mail) 915 King St., West

Mack, Wilbur O.—Associate professor of agricultural engineering, Prairie View College, Prairie View, Tex. (Mail) Box 2333

Marvin, Virgil—Manager, farm power dept., The Toledo Edison Co., Edison Bldg., Toledo, Ohio

Mather, Robert B.—Assistant sales manager, Babson Bros. Co., 2843 West 19th St., Chicago 23, Ill.

Miller, Albert H. — Sales engineer, Delta Irrigation Co. (Mail) RR 3, Newport, Ark.

North, John L.—Manager, irrigation engineering and sales development, Marlow Pumps, Div. of Bell & Gossett Co. (Mail) 100 Pine St., Ramsey, N. J.

Park, William H.—Instructor in engineering drawing, Pennsylvania State University. (Mail) 146 Legion Lane, State College, Pa.

Poetiray, Pierre — Land development and soil conservation engineering, Division of Mechanization of Agriculture, Djakarta, Indonesia. (Mail) c/o Mrs. Barioen, Kernolong Dalam 2 No. 1

Prussing, Jorge A. H.—Assistant engineer, agricultural machinery div., Wessel, Duval & Cia. S. A. C., Santiago, Chile. (Mail) Teatinos 251, Depto. 701

Rosser, David C.—Sales engineer, Southern Irrigation Co. (Mail) 2909 Duane St., Jackson, Miss.

Sewell, John I.—2nd Lt., Corps of Engineers, U. S. Army. (Mail) 04023994, 618 Engr. Co., Ft. Bragg, N. C.

Siler, Frank G.—Field engineer, The Timken Roller Bearing Co., 1518 5th Ave., Moline, Ill.

Vaigneur, Hugh O.—Assistant agricultural engineer, Clemson Agricultural College, Clemson, S. C.

Vann, James M. Jr.—Sales engineer, Aluminum Co. of America, 1800 Rhodes-Haverty Bldg., Atlanta 3, Ga.

Vincent, Charles R.—General partner, Vincent & Co., Box H, King City, Calif.

Weilein, Leras G.—Senior draftsman, research engineering div., John Deere Waterloo Tractor Works, Waterloo, Iowa

Weisenborn, Howard E. — Sales engineer, Delco Products Div., General Motors Corp., Dayton 4, Ohio. (Mail) 3380 Needmore Rd.

Transfer of Membership Grade

Ali, Syed A.—Advanced designer, advanced engineering dept., International Harvester Co., 2919 S. Western Ave., Chicago 8, Ill. (Associate Member to Member)

Arms, Milo F.—Design engineer, The C. O. Bartlett & Snow Co., Cleveland 30, Ohio. (Mail) 6439 Newland Rd. (Associate Member to Member)

Brooks, Fred R. — Product engineer, International Harvester Co., Stockton, Calif. (Mail) 1235 Sheridan Way. (Associate Member to Member)

Cox, William T.—Specialist in farm buildings, agricultural extension service, Alabama Polytechnic Institute, Auburn. (Mail) PO Box 1643. (Associate Member to Member)

(Continued on page 280)

Farm Equipment Engineering is a

CONTINUED STORY

In farm equipment design—and application—there are few one-chapter success stories. Every machine which makes a lasting contribution to power farming has a history of continued improvement.

In addition, some, like the ALL-CROP Harvester, have found constantly wider application. Twenty years ago, the combine was considered a grain-harvesting machine, primarily limited to big acreages west of the Mississippi.

Today, ALL-CROP Harvesters are used around the world in more than 100 crops, and on thousands of family-size farms. Combining has become the accepted harvesting method for beans and seed crops, as well as for grains.

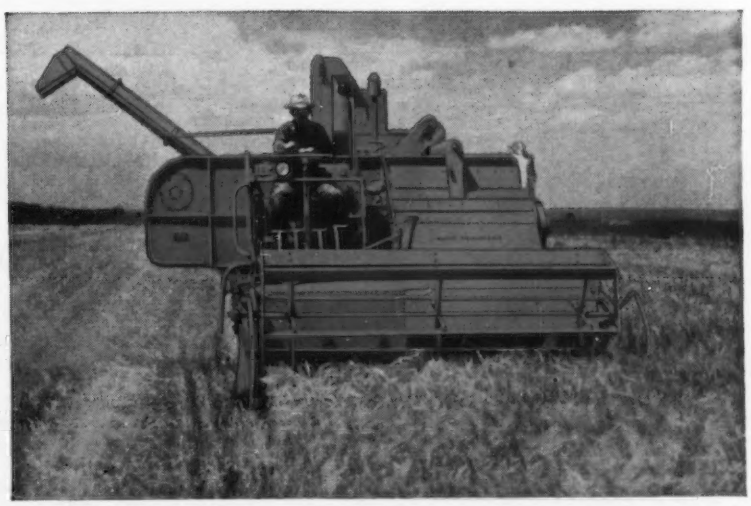
At the same time, Allis-Chalmers engineering has provided continuous improvement of the basic design. Latest example is a pull-type machine . . . the new "Big-Bin" Model 66, with greater bin capacity and the ability to "unload on-the-go" . . . for more non-stop harvest hours every day.

20 years of harvesting leadership

Here is true ALL-CROP Harvester performance extended into the self-propelled field. The same multiple-crop ability and simplicity of adjustment make the Model 100 as outstanding in grass and legume seed harvesting as the famous Model 66.

Both machines have a thrifty price, which comes from efficient manufacture and large volume—making an ALL-CROP Harvester, pull-type or self-propelled — a profitable investment for the family farm.

It's a continued story in better farming and better living, as well as in engineering achievement.



ALL-CROP is an Allis-Chalmers trademark.

ALLIS-CHALMERS
TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

Applicants for Membership

(Continued from page 278)

Levorson, Alton G.—Agricultural engineer, Chisholm-Ryder Co., Niagara Falls, N. Y. (Associate Member to Member)

Templeton, Hugh A. — Field service engineer, Canadian Colombo Plan Agricultural Engineer, Government of Sind, Pakistan. (Mail) c/o Mrs. G. E. Frost, 10 Langley Gardens, Bromley, Kent, England. (Associate Member to Member)

Zollars, Richard U.—Senior design engineer, John Deere Ottumwa Works, Ottumwa, Iowa. (Mail) 409 W. Maple. (Associate Member to Member)

New Products and Catalogs

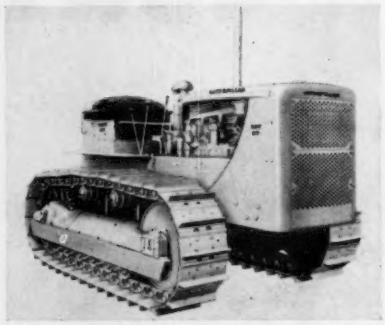
(Continued from page 268)

Farm Lighting Promotion

Edison Electric Institute, 402 Lexington Ave., New York 17, N. Y., will send on request to interested readers its folder which contains plans and materials for promoting farm lighting by electricity. A particular feature of this material is a descriptive leaflet of a slide kit for farm electrification speakers which includes 20 slides and a speaker's script. Single kits sell for $5.00 each.

New Track-Type Tractor

Caterpillar Tractor Co., Peoria, Ill., has announced a new model track-type tractor, the D7. The engine in this new tractor has 128 hp at 1200 rpm compared to 108 hp at 1000 rpm in the previous model. Its maximum drawbar pull is 28,700 lb, approximately 3500 lb more than its predecessor. An innovation designed into this tractor, to improve its operation, is an engine balancer



which reduces vibration and permits the 4-cylinder engine to operate at 1200 rpm with the same degree of smoothness as a 6-cylinder design. Other new major engineering features include redesigned engine block, new fuel-injection system, new starting engine, new radiator, larger fuel tank, new fuel filter system, redesigned oil filter base adapter, and improved air cleaner.

Welded Tubing Handbook

Van Huffel Tube Corp., Warren, Ohio, will send on request to interested readers a copy of its new 32-page handbook, which covers the whole range of sizes, gages and tolerances on square, round, rectangular steel tubing and special cold-formed shapes. It also covers physical properties, elements of sections and other data of value to engineers and designers. It is in every sense an engineer's handbook, apparently prepared by engineers for engineers.

Mounted Side-Delivery Rake

Ford Motor Co., Tractor and Implement Div., Birmingham, Mich., announces a new mounted side-delivery rake featuring a patented power-driven rotary stripper and an acute-angle 5-bar power-driven reel.

The rotary stripper eliminates the need for the conventional stripper-bar basket which reduces clogging and bunching as the hay is removed from the rake teeth.

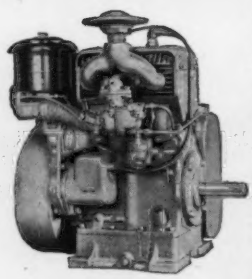
The rake frame is of welded construction and can be easily attached to the 3-point linkage and power take-off of the tractor.

The power-take-off-driven reel is adjustable to either of two speed ranges. This reel-speed change, in combination with a variety of ground speeds, provides flexibility for raking hay or other materials into windrows. In any given gear the speed of the PTO-driven reel is maintained in direct ratio to the ground speed which permits uniform operation even when ground speeds must be varied. The reel is driven by a V belt.

(Continued on page 282)

Famous **MALABAR FARM**

Relies on WISCONSIN-POWERED Overhead Irrigation System!



Model TFD 2-cylinder Wisconsin Engine, used on above installation, (15 hp. at 3000 rpm.) is equipped with Stellite Exhaust Valves and Valve Seat Inserts and positive type Valve Rotators. Automatic High Temperature Cut-off Switch and Low Oil Pressure Switch are also recommended and available for engines engaged in irrigation service.

Drawing water from the pond shown above, Author-Farmer Louis Bromfield's Malabar Farm main garden is irrigated by a Wisconsin-powered Gorman-Rupp Model 53M-TFD pumping unit, rated at 140 GPM at 70 lbs., to 300 GPM at 35 lbs. In the operating scene, each of the six sprinklers is handling 25 gals. of water per minute at 65 lbs. pressure.

Today there is a logical and rapidly increasing demand for Wisconsin Heavy-Duty Air-Cooled Engines for sprinkler irrigation service, in all capacities within a 3 to 36 hp. range, as integral pumping unit power components. Heavy-duty design and construction; thrust-absorbing tapered roller bearings at BOTH ends of the crankshaft; easily serviced rotary type, high tension OUTSIDE magneto, plus efficient AIR-COOLING at temperatures up to 140° F., are features that make Wisconsin Engines especially desirable for this type of farm and orchard service.

You can't do better than to specify "Wisconsin Engines" for *your* sprinkler system installations. Write for Bulletin S-164.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

New Holland's 130-bu. Spreader shreds the densest chunks of matted material

Here's why New Holland Spreaders don't show their age

THIS big P.T.O. Spreader, with its many *exclusive* advanced features, is not only built to dish it out—but it can take it too!

You can wash down a New Holland Spreader—after weeks of work—and the finish will come up practically like new. Special steps taken during the manufacture make this possible.

For example: after all shearing, forming, piercing, notching and welding operations, metal parts are cleaned and degreased in both water and acid rinses. Remaining residue is wiped from parts by hand.

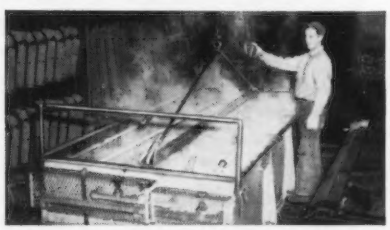
Next, a Metalife primer is sprayed over all these metal parts. This is a preservative that protects and seals against the corrosive action of bacteria, acids and weather.

This is followed by a coat of New Holland red paint. To maintain proper spray painting conditions, temperature and viscosity of paint are checked twice daily and, naturally, each time paint is mixed.

Special treatment is also given the dense Georgia pine flooring before painting. For one hour before assembly, floor boards are completely immersed in a Pentacote preservative solution—tested by the U. S. Department of Agriculture for water-repellent and non-rotting qualities. In this way even the ship-lapped joints are protected.

Add to all this the continual quality checks of materials used and you have a spreader that will wear its age well after years of service. The New Holland Machine Co., New Holland, Pa. A subsidiary of The Sperry Corporation.

Metal side sheets ready to be immersed in wash tank solution of 7 oz. of Fosbond 22 per gal. of water.



After 15 minutes in 180° solution, side sheets will receive hot water and acid rinses before painting.

Yellow pine floor boards draining after being submerged for one hour in fungicidal sealer bath.

NEW HOLLAND

"First in Grassland Farming"

New Products and Catalogs

(Continued from page 280)

New 4-Row Corn Planters

J. I. Case Co., Racine, Wis., announces introduction of its new 4-row 424E and 444E corn planters with new features such as double-chain drive for uniform, continuous power, and low-positioned seed boxes for easy filling. In these machines the seed plates can be changed without removing the seed. Both models are designed with the company's Eagle Hitch for convenient mounting. The 424E model can be used for check planting, hill drilling or regular drilling. The 444E model is used for drilling only and has a wide variety of spacing available.

Planting accuracy of these machines is achieved by means of the gear-drive mechanism which provides smooth and continuous revolutions of the seed plates. To further assure accuracy, seed box parts are machined for precision fit. Seed plates are now designed for more ready filling, and a single cut-off is utilized for simplicity.

Bulletin on Nickel-Copper Alloy Steels

The International Nickel Co., Reader's Service Section, 67 Wall St., New York 5, N. Y., will send on request to interested readers a copy of its 48-page booklet illustrating the wide application of nickel-copper high strength low alloy steels in the agricultural and other fields. The booklet describes the working methods, mechanical properties, compositions and availability of seven steels of this class. It includes numerous tables and charts and more than 100 illustrations.

Convertible Moldboard Plow

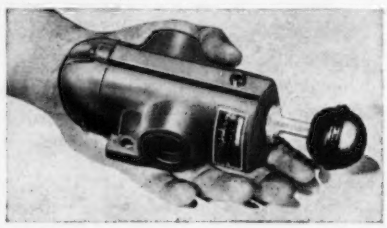
The Oliver Corp., 400 West Madison St., Chicago 6, Ill., has introduced a new line of moldboard plows of the truss-frame type that are convertible in both size and furrow-cutting width. The company says the chief advantage of this two-way convertibility is in matching the plow to changing field conditions and to the power the farmer uses. With this plow he can add a third bottom to the basic two-bottom unit, or vice versa, also change the furrow width to cut 12, 14 or 16 inches.

Another feature of the plow is a trip-spring release which permits the bottom to swing back and completely ride over the obstruction encountered. The bottom can be reset by simply backing up the plow, without the operator leaving the tractor seat or even lifting the plow from the ground.

Other features of the plow are that it is equipped with original Raydex bottoms with throw-away shares developed by Oliver almost 20 years ago.

On-and-Off Hydraulic Valve

Wisconsin Hydraulics, Inc., 3165 N. 30 St., Milwaukee 16, Wis., announces a new light-weight, positive-locking, push-pull-type, on-and-off valve with capacities from 8 to 10 gpm (1000 psi), which is manually operated and can be readily adapted to remote control.



This new unit fills the demand for a low-cost, easy-mounting valve for shutting off part of a hydraulic system; it will cut off all flow at pressures up to 1000 psi. It can be mounted in any position and is equipped with dust and moisture seals.

Row-Crop Planter Catalog

Allis-Chalmers Manufacturing Co., Tractor Div., Milwaukee 1, Wis., will send on request to interested readers a copy of a new 24-page catalog (TL-1006) descriptive of its complete line of tractor-mounted row-crop planters and fertilizer equipment designed, engineered, and built by Allis-Chalmers for its farm tractors. Each model in the planter line is illustrated and described as are the special attachments and accessories available. In addition the catalog outlines mechanical and construction features of the planters and attachments and accessories.

(Continued on page 284)

"CUSTOM MADE"
TO YOUR SPECIFICATIONS

ROCHESTER TRACTOR GAUGES
Meet Your Field Requirements

Rochester sales engineers have the answers to your tractor engine gauge questions. Their years of experience and training enable them to give you the type of suggestions and engineering assistance that will save you engineering time . . . help you cut costs.

ROCHESTER ENGINE GAUGES are setting standards in reliability and accuracy. And full flexibility of application is yours with Rochester's basic designs that can be modified to meet your specific requirements.

So, look to Rochester, not only for greater value in accurate and dependable engine gauges, but for the type of engineering assistance that assures the right gauge at the right cost in every application. Write, wire, or phone Rochester Mfg. Co., Rockwood Street, Rochester, N. Y.

Rely on Rochester

ROCHESTER
MANUFACTURING COMPANY, INC.
DIAL THERMOMETERS GAUGES AMMETERS

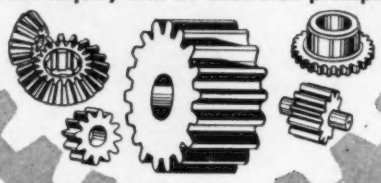
ROCHESTER DEPENDABLE ACCURACY GAUGES

GEARS

of every description—made to your specifications

The gears you buy from E. B. Sewall are made by men who are fussy about specifications. They've got the finest equipment and know how to use it. If you specify .0002" tolerance, you get it—at each tooth on every gear we ship. We're in a brand new plant, equipped to handle your gear requirements. Send specifications and quantity for our quotation.

Your inquiry will be answered promptly



SEWALL

E. B. Sewall Mfg. Co., 702 Glendale St., St. Paul 14, Minn.

For **PORTABLE SPRINKLER IRRIGATION** that ***WORKS BETTER*** with ***LESS WORK . . .***

Always use . . .

Streamlined

McDowell Irrigation COUPLINGS

No Hooks, Latches or Gadgets

Easier to assemble and disassemble!

Easier to carry and move!

Easier to stack and store!

The ORIGINAL AUTOMATIC PRESSURE-LOCK DESIGN . . .

In this patented construction, water pressure provides a tight seal and positive lock automatically—at both high and low pressures. No tools are needed—and there are no clamps, yokes or latches to bother with, break or wear out. The result: a McDowell Coupling portable irrigation system requires less work, less upkeep . . . saves time and effort . . . does a better job . . . and costs less in the long run. Want proof? Ask your local McDowell dealer for a demonstration.

McDowell—The Best Coupling Made!

Made in sizes 2" through 8".

For Complete Details . . . Free Booklet . . .
MAIL COUPON TODAY!

Name_____ 4-D

Address_____

City_____ Zone____ State_____

McDOWELL MANUFACTURING CO. Pittsburgh 9, Pa.

Years of wear in SILENTBLOC bearings

without Lubrication!

Silentbloc rubber-in-metal bearings will correct misalignment, reduce noise, cushion shock and handle oscillating motion without lubrication of any kind through long years of operation. They have already proven themselves under tough operating conditions in tractors, combines and other types of agricultural machinery.

For the full story on Silentbloc write to The General Tire & Rubber Company, Industrial Products Division, Dept. F, Wabash, Indiana.

"From Plans to Products in Plastics and Rubber"

THE GENERAL TIRE *Industrial Products Division* WABASH INDIANA

These are General Tire Industrial Products in Industry

Silentbloc vibration and shock mountings · Silentbloc bushings · Silentbloc bearings · Oil & hydraulic seals · Bonded to metal rubber parts · Hydraulic brake parts · Metal stampings · Extruded & molded rubber · Extruded plastic · Polyester glass laminates · Sponge rubber · Glass run channel · Vibrex® fasteners.

New Products and Catalogs

(Continued from page 282)

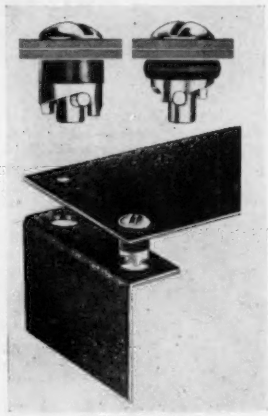
Scraper Attachment

Allis-Chalmers Mfg., Co., Tractor Div., Milwaukee, Wis., announces a new scraper for use with its model WD-45 tractor, which is 6-ft long, has a 14-in-high moldboard and is fitted with a replaceable cutting edge of wear-resistant steel. Its length can be increased by addition of two 1½-foot moldboard extensions complete with replaceable cutting edges and attaching parts. Special equipment to speed work and increase the versatility of the unit includes end plates for leveling fields and filling in low

spots. Construction of the scraper features a heavy tubular beam with bolted and welded assemblies. It is hitched to the tractor through a snap-coupler hitch system and is operated through the tractor's hydraulic system.

Quick-Release Panel Fastener

The General Tire & Rubber Co., Industrial Products Div., Wabash, Ind., announces a revolutionary new quick-release panel fastener. This new unit, called the Vibrex fastener, is a half-turn panel-to-base fastener which combines the functions of a positive lock with those of an elastic isolator. The multifunction fastener floats

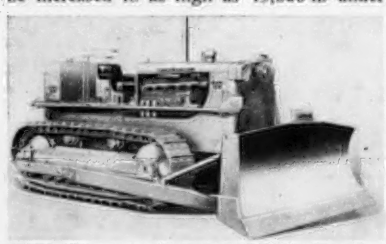


the entire panel in live, resilient rubber. According to the company, the fastener smothers rattles and noise, and isolates vibration and shock. In addition, it compensates for misalignment between panel and base. According to the manufacturer, it is the only quick-acting fastener which is completely water, dust and pressureproof.

191-hp Track-Type Tractor

Caterpillar Tractor Co., Peoria, Ill., has introduced its new D8 track-type tractor in two models, a torque converter (series D) and a direct drive (series E).

With a three-stage 5:1 torque converter, the series D model has speeds up to 7.4 mph through a constant-mesh transmission which has three speeds forward and three in reverse. The series E model has five forward speeds and three in reverse. With standard transmission, the rated drawbar pull of the series E is 39,150 lb, which can be increased to as high as 45,020 lb under



proper traction and weight conditions. Optional transmissions will give higher drawbar pulls. The series D model has over 50,000 lb of drawbar pull; however, the torque-converter drive on this model automatically adjusts drawbar pull to the load within the given speed ranges.

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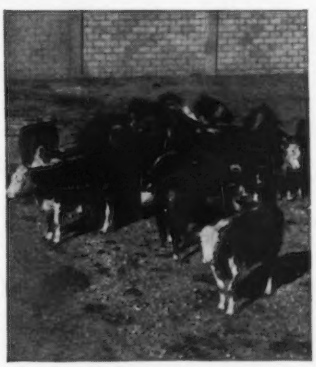

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NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN—AUGUST—O-251-648, 244-649. SEPTEMBER — O-276-650, 262-651, 293, 654. OCTOBER—O-326-656, 332-657, 327-659, 353-660. NOVEMBER—O-374-661. 1955—JANUARY—O-434-666, 437-667, 438-668, 441-669, 442-670, 447-672. FEBRUARY—O-2-702, 23-703, 19-704, 32-705, 33-706, 44-707, 44-708, 18-709. MARCH—O-55-710, 56-711, 15-712, 61-713, 71-714, 87-715.

POSITIONS WANTED — AUGUST—W-237-142, 265-144. SEPTEMBER — W-246-147, 294-150. OCTOBER—W296-152, 330-153, 340-154, 365-155, NOVEMBER — W-369-157, 372-159, 375-160. DECEMBER — W-400-161, 391-164, 409-165, 411-166. 1955—JANUARY — W-429-168, 427-169. FEBRUARY—W-34-1. MARCH—W-17-2, 52-3, 48-4, 84-5, 27-6.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER for teaching and some research in farm shop, utilities, electricity or farm structures, farm surveying and mapping, in a state technological college in the Southwest. Renewable 9-month contract, starting September 15. Approval expected for summer work. Advanced degree preferred. Well-qualified man with BS deg will be considered. Usual personal qualifications for college teaching. Teaching or application experience in subject matter fields desirable. Salary open. O-120-716

AGRICULTURAL ENGINEER for research in crop handling methods and equipment with agricultural experiment station in Northeast, as member of a team including an industrial engineer, an agricultural economist, and a plant physiologist. Age, under 35. MS deg in agricultural engineering, or equivalent. Experience in agricultural engineering research, or crop handling or processing work. Interest in machinery and equipment development. Ability to meet and work well with others. Excellent opportunity in expanding research program. Usual social security and hospitalization. Exceptional retirement program. Salary open. O-142-717

AGRICULTURAL ENGINEER for product development and improvement in fields of farm and grain storage structures, grain, storage, drying and handling equipment and barnyard equipment, with established manufacturers of sheet metal products in Midwest. Age 25-40. BS degree in agricultural or mechanical engineering. Farm background and experience in grain drying, farm structures, or related equipment. Able to meet public. Some travel required. Opportunity dependent on ability and initiative. Retirement, hospitalization and other benefits. Salary open, state requirements in application. O-125-718

AGRICULTURAL ENGINEER for product, design and development; mechanical graduate preferred; knowledge of tool engineering, process planning and methods essential. Agricultural background preferred. Must be congenial and ambitious. An excellent opportunity for right man. Salary open. O-155-719

AGRICULTURAL ENGINEER to head agricultural engineering extension section with a staff of 5, in division of agricultural extension in a major eastern agricultural state. Age 40-50. BS and preferably MS deg in agricultural engineering. Experience in work with land-grant institution required. Extension experience preferred but research or teaching background acceptable. Usual personal qualifications for extension work. Requires maintaining good cooperative relations with research and teaching staffs, and with other subject matter sections in the Extension Service. Position open now. Opportunity for merit increase in salary and for advancement in the Extension Service. Salary $7500 or higher, subject to usual deductions for benefits, etc. O-143-720

ASSISTANT CURATORS (4) — Henry Ford Museum and Greenfield Village, mechanical arts department, featuring industrial development in the following major areas: transportation, agriculture, communication, power. Duties include curatorial responsibility for collections in one of the above major areas, close cooperation with department of education and supervision of restoration requirements. Several years' museum experience, graduate AE, ME, EE or equivalent, graduate work in history, technical editing, teaching, or research desirable. Salary—open. 0-173-721

NEW POSITIONS WANTED

AGRICULTURAL AND MECHANICAL ENGINEER for design and development or management in farm power and machinery field with manufacturer in United States. Married. Age 35. No disability. Canadian, with all necessary documents for U.S.A. immigration visa. BS deg in mechanical engineering, Queen's University, Kingston, Ontario, 1943. War commissioned service in RCAF. Navigator, navigation instructor and flying officer. Commercial engineering experience in aircraft power plant engineering; small business practice and management, charge of product design, tooling and production, cost and inventory control, methods and estimating, quality control, personnel management, defense contract negotiation and technical sales, with manufacturer of high-pressure pumps, agricultural equipment, sheet steel and special welded products, precision machine components and assemblies for aircraft, radar and ordnance contracts, and aluminum and bronze sand castings. Available on 60-days notice. Salary $10,000-12,000. W-74-7

AGRICULTURAL ENGINEER for design, development or research in rice production and equipment, or related extension or teaching, Texas or Gulf Coast area, preferably with manufacturer, processor, or farming operation. Will travel. BS deg in agriculture, Texas A & M College. Married. Age 26. No disability. Several years experience in rice production including planting, irrigation and harvest. Air Force commissioned service 2 yr with experience as assistant installation engineer supervising new construction and maintenance at an Air Force Base. Currently mud engineering sales and service for oil drilling operations. Available June 1. Salary $400/mo. W-114-8

AGRICULTURAL ENGINEER for design, development, research, extension, or teaching, soil and water field, with industry or public agency, anywhere in USA, preferably not in large city. Married. Age 37. No disability. BS deg in agricultural engineering, 1949, University of Minnesota. MS deg in agricultural engineering, 1950, Iowa State College. War enlisted and commissioned service in Field Artillery, nearly 4 years. Present position with SCS nearly 5 years, as area engineer for 8 counties, on preliminary studies, field surveys, hydrologic studies, preliminary and final reports on engineering works, preparing specifications, supervising construction, and training other employees in engineering phases of their work. Legal engineer on three drainage projects. Registered engineer in Minnesota. Available on 30 days notice. Salary open. W-129-9

AGRICULTURAL ENGINEER for extension, teaching, research, development, or writing, in soil and water field, with industry or public service in Midwest or West. Single. Age 29. No disability. BS deg 1952, MS deg in agricultural and civil engineering expected in June, South Dakota State College. Farm background and 2 yr full time farm experience since high school. Infantry basic and finance training in 1¼ yr Army service. Civil engineering, 2 yr in US Civil Service, inspection of transmission lines and substation concrete construction. Research assistant one-half time while working for advanced degree. Available July 1. W-4-10

AGRICULTURAL ENGINEER for extension teaching, or research in soil and water field (soil erosion or irrigation) with public service, consultant, or farming operation, preferably in Midwest. Married. Age 22. No disability. BS deg in agricultural engineering, 1954, MS deg in agricultural engineering expected in June, University of Missouri. Farm background. Two summers as PMA fieldman and SCS assistant. Two summers working with members of agricultural engineering staff, University of Missouri, on terracing, irrigation and related water management research. Thesis is on parallel terracing methods. Available July 1. Salary open. W-133-11

AGRICULTURAL ENGINEER for design, development, research, extension, or writing in rural electric or product processing field with utility, manufacturer, processor, or consultant in Northeast area. Will travel if necessary. Single. Age 28. Nearsighted, good correction. BS deg in agricultural engineering, 1953, Pennsylvania State College. MS deg in agricultural engineering, 1955, Michigan State College. Full time farm work 5 yr. Research at Michigan State College, 2 yr. Available May 1. Salary $4500. W-134-12

AGRICULTURAL ENGINEER for sales, service, or management in power and machinery or rural electric field with manufacturer, anywhere in U.S. Will travel. Married. Age 35. No disability. BS deg in agricultural engineering, 1948, University of Illinois. Sales representative with farm equipment manufacturer 6 yr. With electrical contractors' association, promoting rural electrification, nearly one year. War enlisted and commissioned service nearly 6 yr, including experience in charge of heavy bombardment squadron maintenance. Available on 30 days notice. Salary open. W-131-13

AGRICULTURAL ENGINEER for design, development, or research in farm equipment or structures, with established manufacturer in small city in Northeast or North Central area. Married. Age 29. No disability. MS deg in agricultural engineering, 1952, Pennsylvania State University. More than 3 yr experience in agricultural research, extension, writing, and design and development of farm equipment and structures. War non-commissioned service in Army. Available on approximately 30 days notice. Salary open. W-67-14

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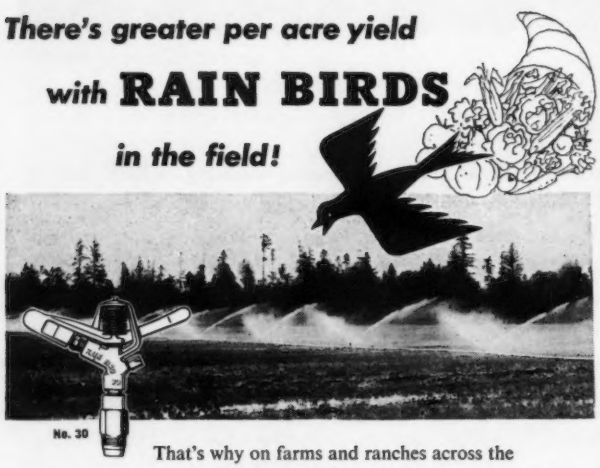

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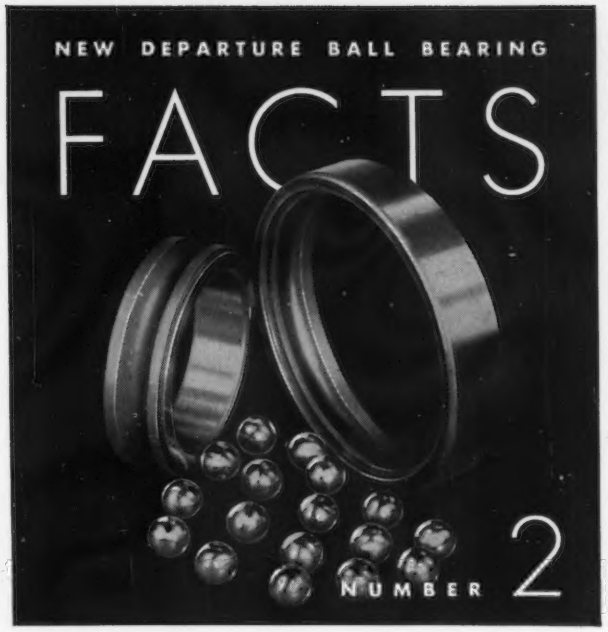

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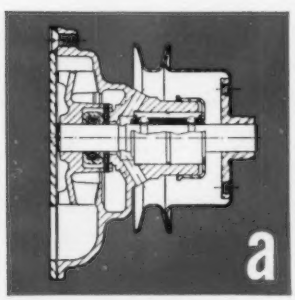

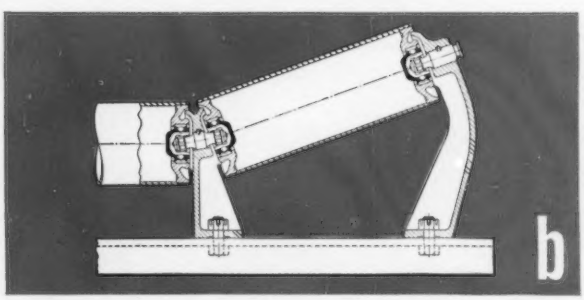

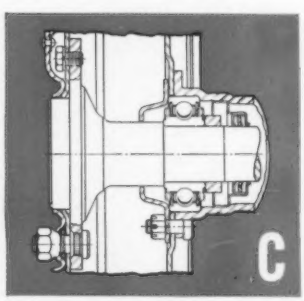

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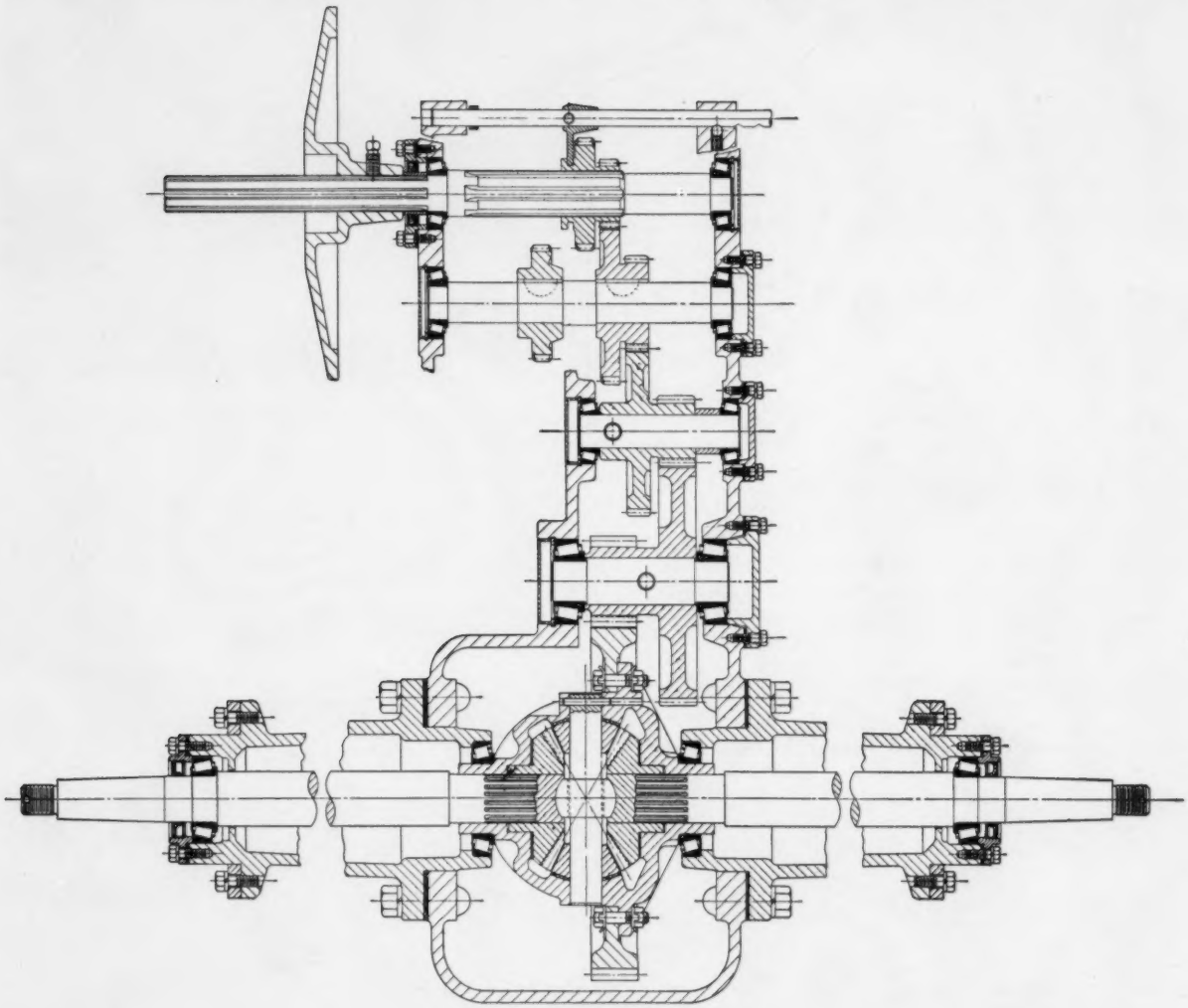

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